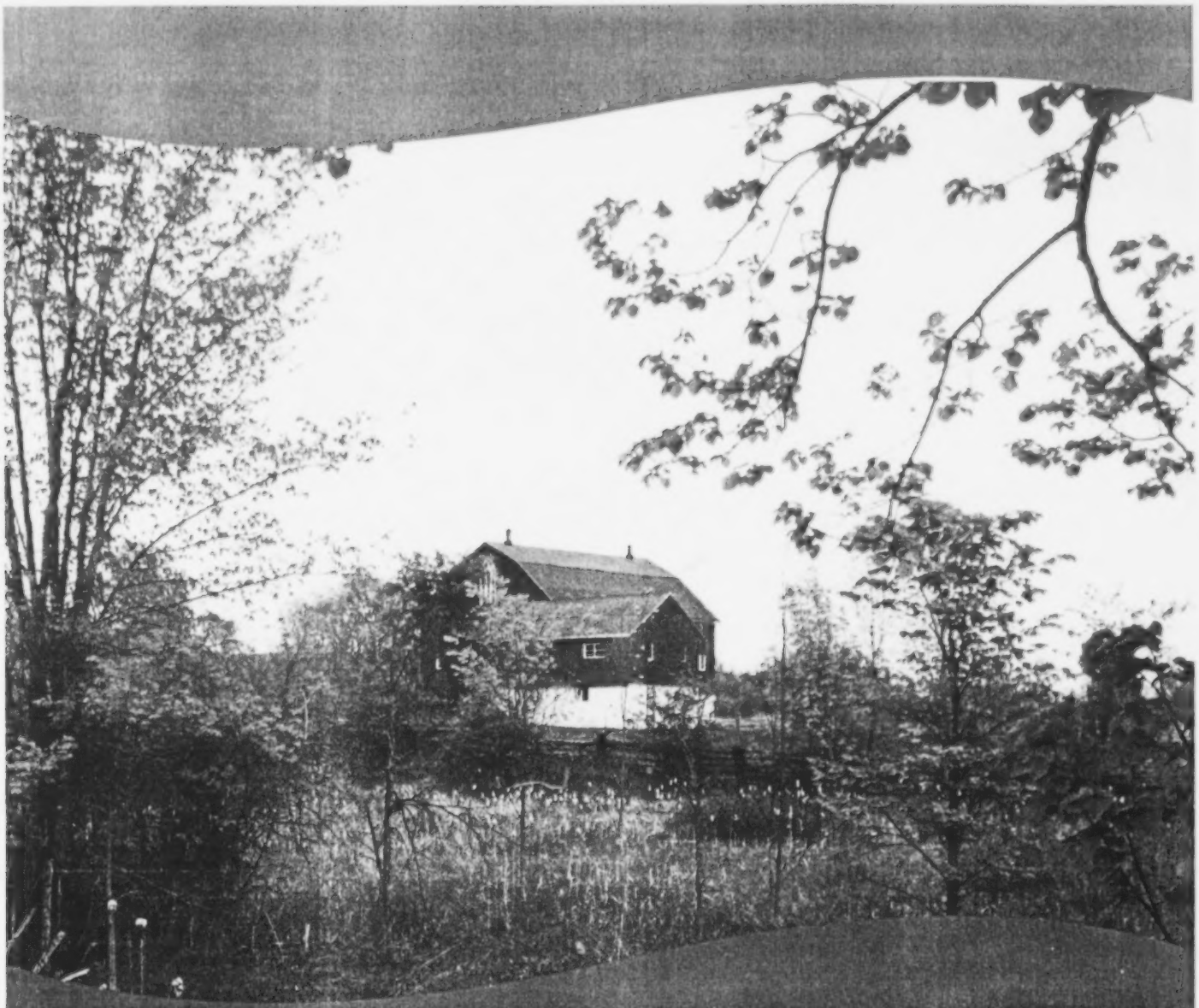
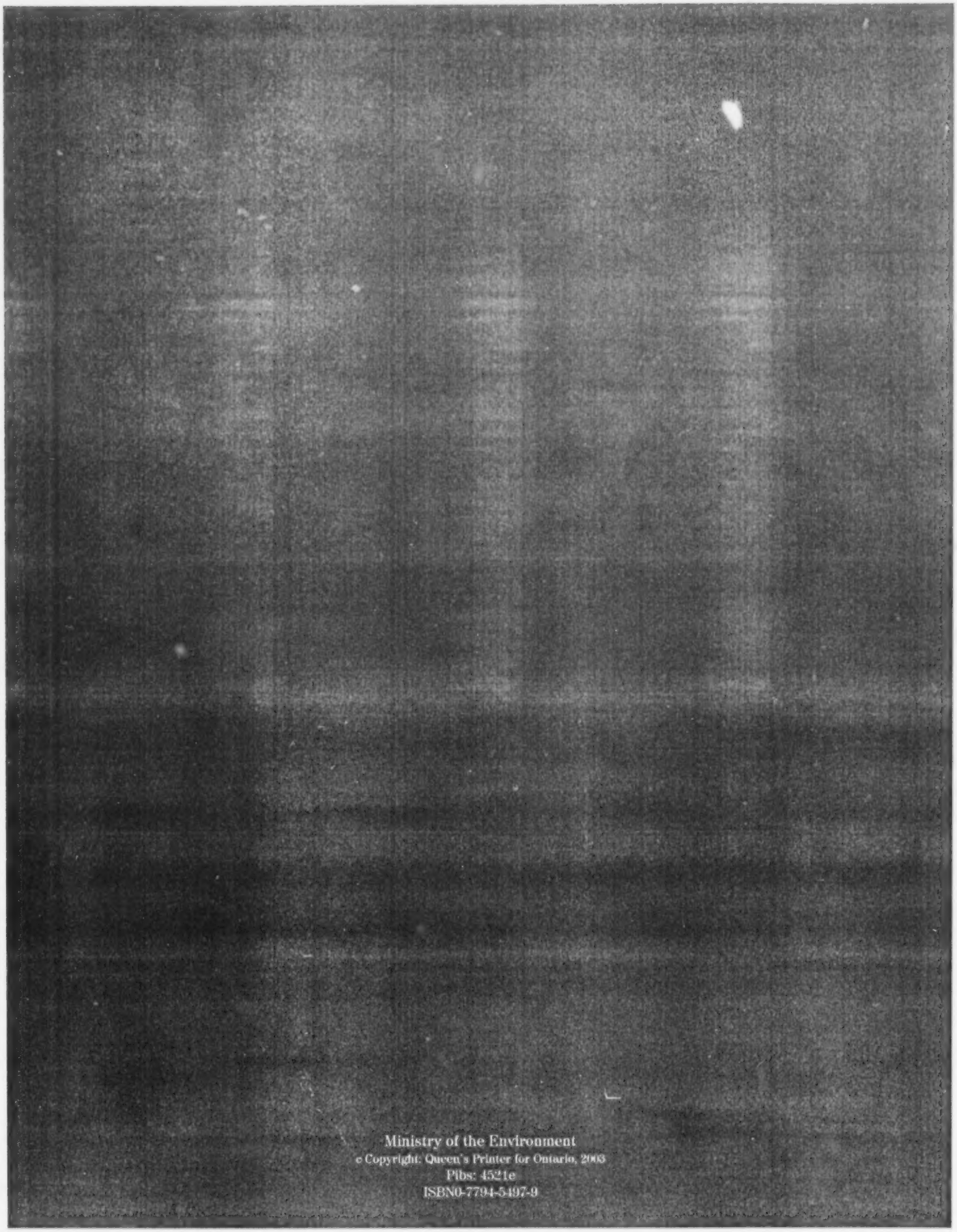


Air Quality in Ontario

2001 Report

Ontario



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2001 Report Findings

• In 2001, the people of Ontario experienced the greatest number of smog advisory days (23) since the inception of the provincial Smog Alert program in 1993.

• While it is clear that more work needs to be done to improve Ontario's air quality and reduce smog in the province, data collected during the past 31 years continue to show an improving trend towards cleaner air.

• Carbon monoxide concentrations were reduced by 85 per cent from 1971 to 2001.

• Sulphur dioxide concentrations were reduced by 82 per cent from 1971 to 2001.

• Nitrogen dioxide concentrations were reduced by 33 per cent from 1977 to 2001.

• The trend in ozone peak concentrations decreased from 1982 to 2001. However, there was an increasing trend in ozone mean concentrations during the same period. Continued efforts are needed to address this issue.

• Data analysis strongly indicates that neighbouring U.S. states - namely Ohio, Illinois and Michigan - are significant contributors to elevated levels of ozone and PM2.5 throughout southern and central Ontario, as far north as Sudbury and east to Ottawa.

• Good to very good AQI readings were reported more than 92 per cent of the time in 2001.

• Levels of selected volatile organic compounds (VOCs) in 2001 continued to remain below existing provincial criteria.

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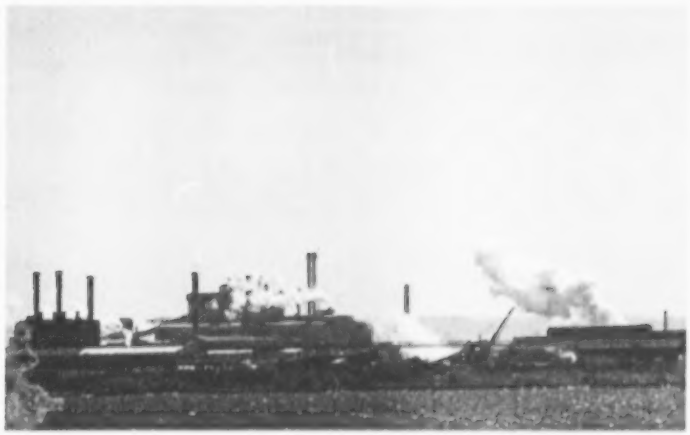
Overview



Air pollution is of concern to many people who live in Ontario. Average air pollution levels in Ontario during the past 31 years have decreased, but smog remains a concern, especially in southern Ontario. Air pollution comes from many different sources, including stationary sources such as factories, power plants and smelters; mobile sources such as cars, buses, trucks, planes and trains; and finally, natural sources such as forest fires, windblown dust and biogenic emissions from vegetation.

Many pollutants, including those that form smog (ozone and fine particulate matter), remain in the atmosphere for long periods of time. These air pollutants are generated both locally and regionally, and carried hundreds of kilometres by winds from province to province and country to country, affecting areas far removed from the source of the pollution.

This report focuses on air concentrations based on measurements of pollutants in the ambient outdoor air to determine the state of air quality in the province of Ontario.

The Ontario Ministry of the Environment collects continuous air quality data at 80 monitoring sites across the province. These data are used to determine the state of air quality in Ontario and help develop abatement programs to reduce the burden of air pollutants, address key air issues and assess the efficacy of policies and programs. Ambient air monitoring in Ontario provides information on the actual concentrations of selected pollutants in communities across Ontario. Table 1.1 shows the relationship between monitored air pollutants and current air issues.

For the past 31 years, the Ministry of the Environment has been monitoring air quality across Ontario and using this information to:

- inform the public about outdoor ambient air quality;
- assess Ontario's air quality and evaluate long-term trends;
- identify areas where criteria are exceeded and identify the origins of pollutants;
- provide the basis for air policy/program development;
- provide quantitative measurements to enable abatement of specific sources;
- determine the significance of pollutants from U.S. sources and their effects on Ontario;

- provide air quality researchers with data to link environmental and human health effects to air quality; and
- provide smog alerts for public health protection since 1993.

This report, the 31st in a series, summarises the state of ambient air quality in Ontario during 2001. It covers the measured levels of seven contaminants: ozone (O_3), fine particulate matter ($PM_{2.5}$), sulphur dioxide (SO_2), nitrogen dioxide (NO_2), carbon monoxide (CO), total reduced sulphur (TRS) compounds, and ambient mercury (Hg) in Ontario. Where appropriate, air pollutant concentrations in selected Ontario cities have been compared to the information available in other cities worldwide. These comparisons are not intended to be used as a comprehensive ranking of global pollution levels since data for some key cities with high pollution levels (such as Mexico City) have not been included. The report also summarises the results from the Air Quality Index (AQI) and Smog Alert programs and briefly examines smog episodes in 2001. Results for a selected number of volatile organic compounds (VOCs) are also reviewed. As well, the results of a special air quality study conducted in the Georgian Bay area are briefly discussed. A glossary of terms and a list of abbreviations are also included in this report.

The main focus of the 2001 publication is to report on the state of Ontario's ambient air quality. As in the past, the data for the source monitoring sites will be presented in a separate appendix document, along with the ambient data. Ontario continues to benefit from one of the most comprehensive air monitoring systems in North America. The network is designed to measure continuous air quality at 80 monitoring sites across the province and undergoes regular maintenance to ensure a high standard of quality control. With these data, we can make informed decisions about what needs to be done to protect and improve our air quality.

Table 1.1: Linkages between Air Pollutants and Air Issues

Pollutant	Smog	Acid Deposition	Odour	Visibility/ Soiling	Local vs. Regional
Ozone	Yes	Yes	No	No	Regional
Sulphur Dioxide	Yes	Yes	No	Yes	Local & Regional
Carbon Monoxide	Yes	No	No	No	Local
Nitrogen Oxides	Yes	Yes	No	Yes	Local & Regional
Volatile Organic Compounds	Yes	No	Yes	No	Local & Regional
Particles	Yes	Yes	Yes	Yes	Local & Regional
Total Reduced Sulphur Compounds	No	No	Yes	No	Local

Ground-Level Ozone

Ground-level ozone (O_3) is a gas formed when nitrogen oxides (NO_x) and volatile organic compounds (VOCs) react in the presence of sunlight. While ozone at ground-level is a major environmental and health concern, the naturally occurring ozone in the stratosphere shields the earth from harmful ultraviolet radiation. The formation and transport of ground-level ozone are strongly dependent on meteorological conditions. Changing weather patterns contribute to short-term and year-to-year differences in ozone concentrations.

In Ontario, elevated concentrations of ground-level ozone are generally recorded on hot, sunny days from May to September, between noon and early evening. The diurnal pattern of ozone during a very hot summer day in 2001 is shown in Figure 2.1.

Characteristics, sources and effects

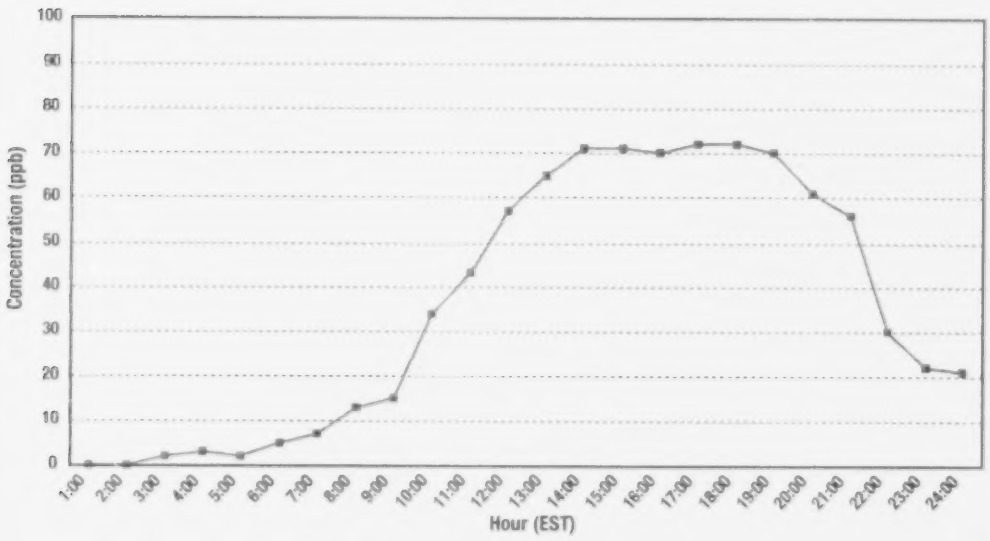
Ozone is a colourless, odourless gas at ambient concentrations, and is a major component of smog.

Ground-level ozone is not emitted directly into the atmosphere. Ozone results from chemical reactions between

VOCs and NO_x in the presence of sunlight.

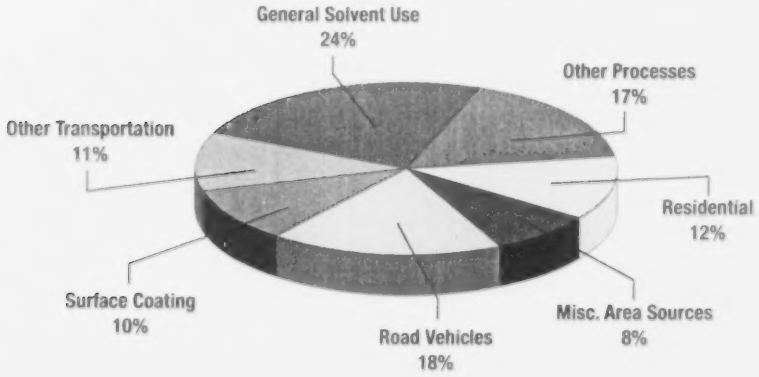
Figure 2.2 shows 2001 estimates of Ontario's VOC emissions from human activity by sector. Transportation sectors accounted for approximately 29 per cent of VOC emissions during 2001. Overall, there has been a 13 per cent reduction in VOC emissions from 1992 to 2001. New vehicle emission standards in the early 1990s and the shift in residential fuel sources from oil and wood to natural gas probably contributed to this decreasing trend. As well, the implementation of Ontario's Drive Clean vehicle inspection program in 1999 has contributed to an additional reduction in VOC levels. (The sources of NO_x are discussed in the

Figure 2.1
Diurnal Pattern of Ozone
(June 26, 2001)



Note: Based on data from the ambient site in London, Ontario.

Figure 2.2
Ontario VOC Emissions by Sector
(Emissions From Human Activity, 2001 Estimates)



Note: Emission data are a combination of reported and projected emission estimates which may be revised with updated source/sector information or emission estimation methodologies as they become available.

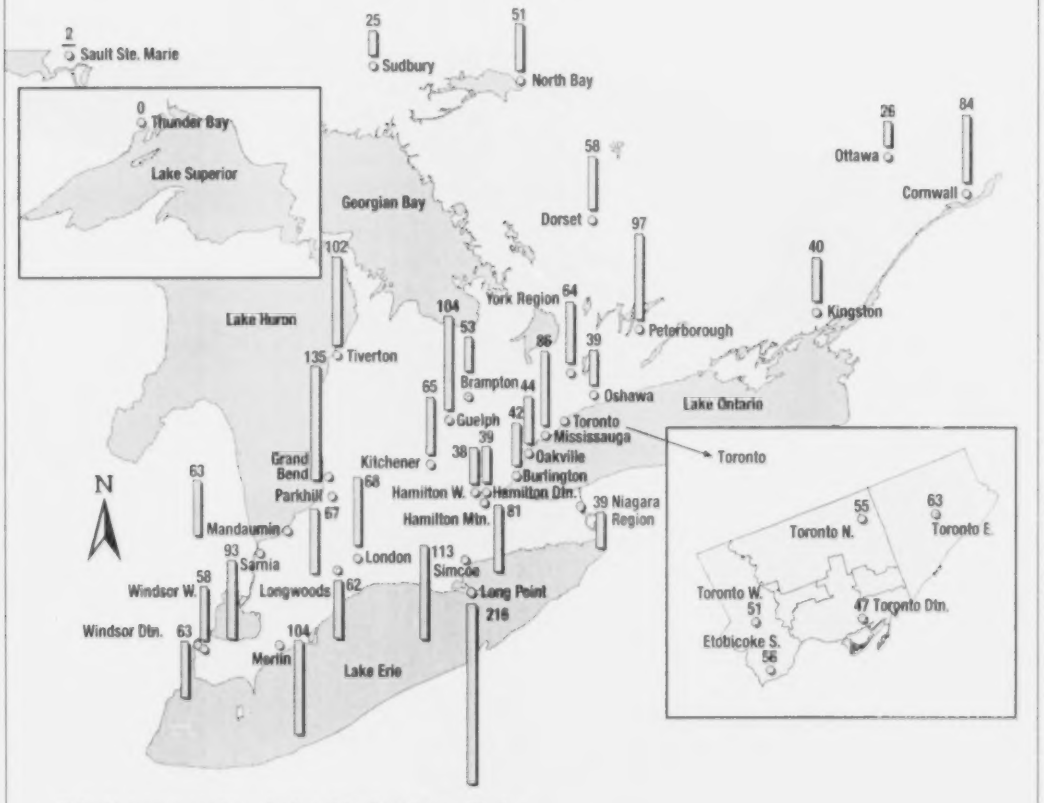
nitrogen dioxide section in Chapter 4).

Ozone irritates the respiratory tract and eyes. Exposure to ozone in sensitive people can result in chest tightness, coughing and wheezing. Children active outdoors during the summer, when ozone levels are at their highest, are particularly at risk of experiencing such effects. Other groups at risk include individuals with pre-existing respiratory disorders, such as asthma and chronic obstructive lung disease. Ground-level ozone is linked to increased hospital admissions and premature deaths. Ozone also causes agricultural crop loss each year in Ontario and visible leaf damage in many crops, garden plants and trees.

Monitoring results for 2001

Ground-level ozone was monitored at 40 locations during 2001. Of these, 38 sites (28 urban and 10 rural) had sufficient data to be used in the analysis presented here. The highest annual mean was 34.7 parts per billion (ppb) which was measured at Tiverton, a rural site on the eastern shore of Lake Huron, while the lowest annual mean was 18.6 ppb measured at the Hamilton West site. Generally, ozone is lower in urban areas because it is removed by reaction with nitric oxide emitted locally by vehicles and other combustion sources. Among urban sites in 2001, Sarnia recorded the highest one-hour concentration (128 ppb). Guelph recorded the greatest number of instances (104 hours) when ozone was above Ontario's one-hour ambient air quality criterion (AAQC) of 80 ppb, and Peterborough recorded the highest annual urban mean (30.7 ppb). At rural sites, Long Point, located on the northern

Figure 2.3
Geographical Distribution of Number of One-Hour Ozone Exceedances Across Ontario (2001)



Note: An ozone exceedance day has at least one hour > 80ppb.

shore of Lake Erie, measured the highest one-hour concentration (137 ppb) and the most number of instances (216 hours) above the provincial one-hour AAQC.

Ground-level ozone continues to exceed its provincial criterion across the province. In 2001, Ontario's one-hour AAQC for ozone was exceeded at 37 of 38 ambient monitoring stations on at least one occasion. Thunder Bay was the only site that did not record any hours of ozone above 80 ppb in 2001.

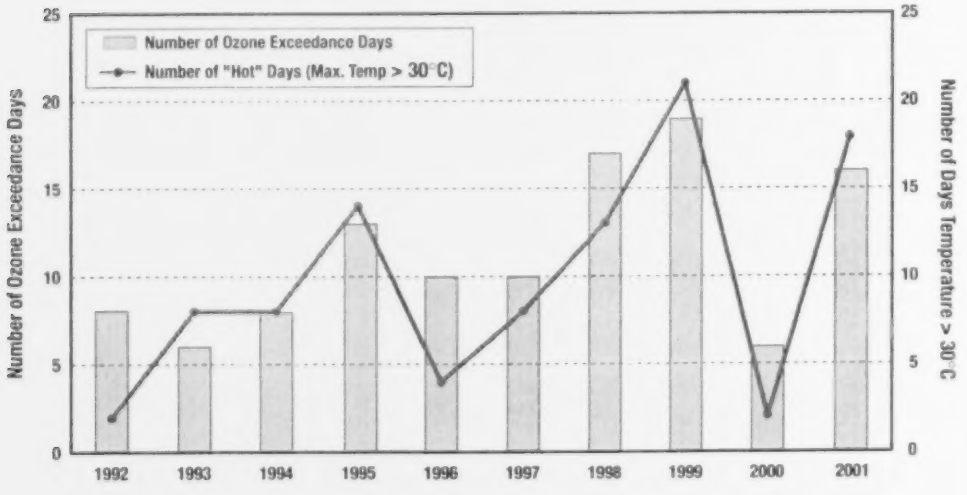
Figure 2.3 shows the geographical distribution of the number of hours of elevated ozone concentrations across Ontario. The significance of transboundary flow is reflected in the relatively higher levels found at rural sites in the southwestern part of the province, along both the eastern shore of Lake Huron and the northern shore of Lake Erie. In general, ozone levels in southern Ontario decrease from southwest to northeast. More than 50 per cent of provincial ozone levels during widespread smog episodes are due to long-range transport of ozone and its precursors from neighbouring U.S. states. This U.S. contribution is expected to be much higher (as much as 90 per cent) in Ontario cities and towns on the northern shores of Lake Erie, the eastern shores of Lake Huron and in the extreme southwest near the U.S. border.

Trends

Interpretation of the 10-year ambient ozone trend is complicated by meteorology and emission changes from day to day. Year to year, ozone levels are strongly influenced by weather. Figure 2.4 shows the distribution of the province-wide ozone exceedances (at least one hour > 80 ppb) and the number of hot days (those days with maximum air temperatures greater than 30°C) from 1992 to 2001. The high number of ozone exceedance days in 1999 and 2001 can be attributed to the high number of "hot" days which are favourable to the formation and transport of ozone, whereas the low numbers of exceedance days in 2000 reflect conditions less conducive to the production of ground-level ozone.

The trend of ozone one-hour maximum concentrations is shown for 1982 to 2001, in Figure 2.5. For the 20-year period, the means of the one-hour maximum concentration range from 98 to 155 ppb, with

Figure 2.4
10-Year Trend for Ozone Exceedance Days and 'Hot' Days in Ontario (1992 - 2001)

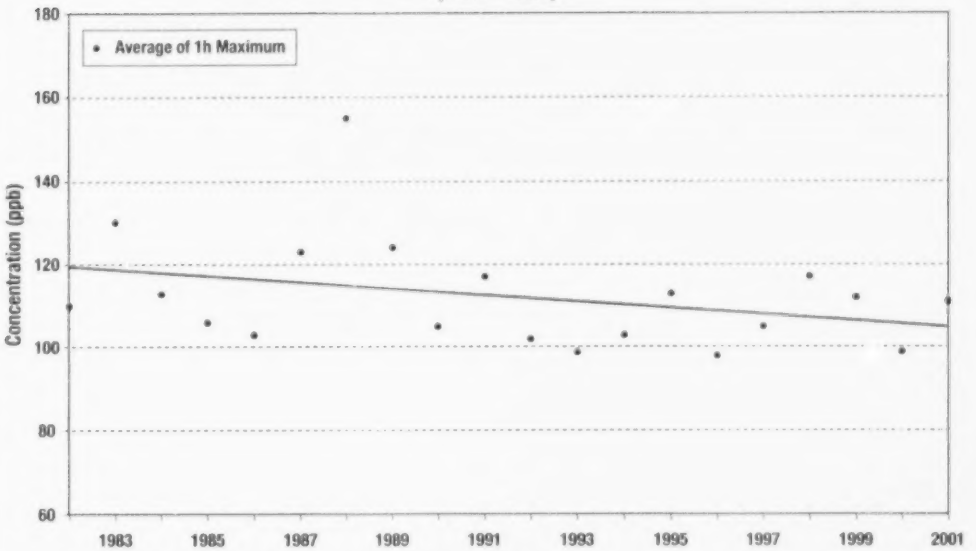


Note: 22 ozone sites operated over 10 years;
"Hot" days based on eight meteorological sites operated over 10 years.
An ozone exceedance day has at least one hour > 80 ppb.

the highest mean recorded in 1988. Overall, the trend line shows random fluctuations but a decreasing trend in ozone concentrations from 1982 to 2001.

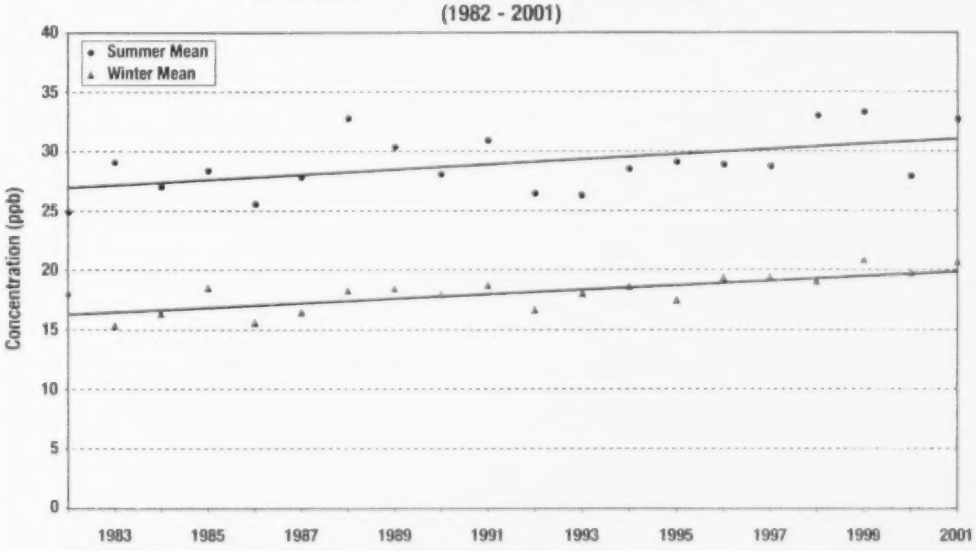
The trend of the ozone seasonal means (summer and winter) for the 18 (12 urban and six rural) long-term ozone sites for the period 1982 to 2001 is shown in Figure 2.6. It shows that there has been an increasing trend in the ozone seasonal means during the 20-year period. The ozone summer means have

Figure 2.5
Trend of Ozone One-Hour Maximum Concentrations in Ontario
(1982 - 2001)



Note: Based on data from 18 ozone sites operated over 20 years.

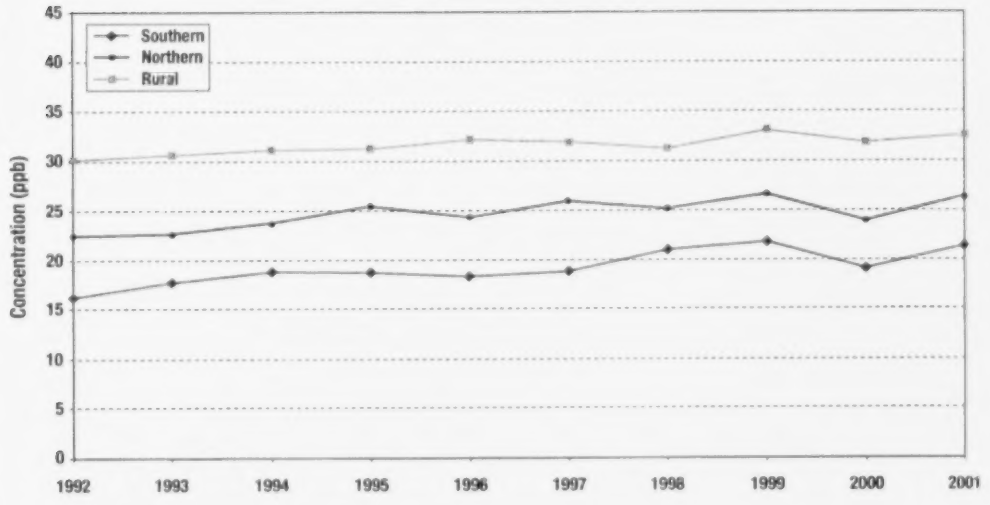
Figure 2.6
Trend of Ozone Seasonal Means at Sites Across Ontario
(1982 - 2001)



Note: Based on data from 18 ozone sites operated over 20 years;
Seasonal definitions - Summer (May to September); Winter (January to April, October to December).

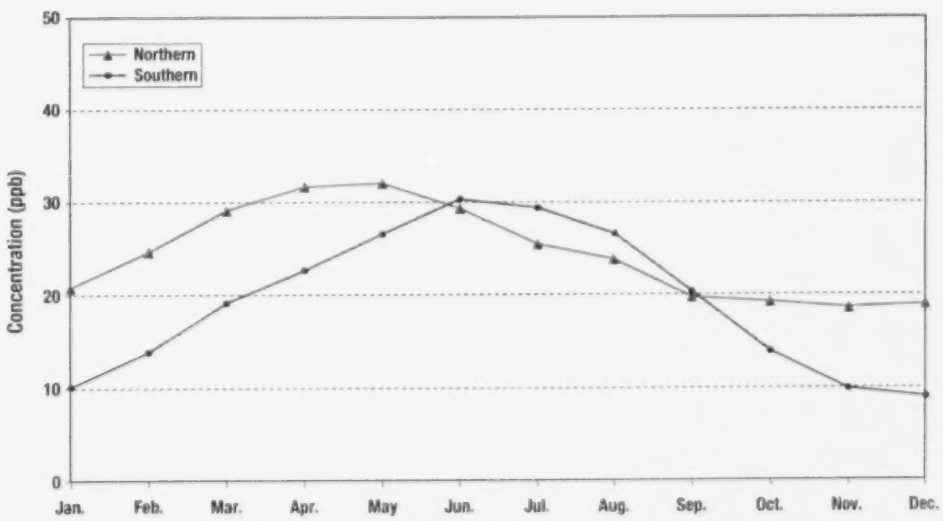
increased by approximately 15 per cent and the winter means by approximately 18 per cent over the 20-year period. The increase of the summer mean is significantly dependent on meteorological factors and the long-range transport of ozone and its precursors from the U.S., whereas the increase of the winter mean indicates an increase in background concentrations of ozone throughout Ontario.

Figure 2.7
Trend of Ozone Annual Means for Southern, Northern and Rural Ontario
(1992 - 2001)



Note: Southern - Windsor, London, Hamilton, Toronto;
Northern - Thunder Bay, Sault Ste. Marie, Sudbury, North Bay;
Rural - Merlin, Simcoe, Long Point, Tiverton.

Figure 2.8
Trend of Ozone Monthly Means in Southern and Northern Ontario
(1990 - 2001)



Note: Northern - Thunder Bay, Sault Ste. Marie, Sudbury, North Bay;
Southern - Windsor, London, Hamilton, Toronto.

The trend of ozone annual means for southern, northern and rural Ontario for 1992 to 2001 is shown in Figure 2.7. It shows that the ozone annual mean concentrations for southern Ontario are consistently about 5 ppb less than those of northern Ontario and about 11 ppb less than those in rural Ontario. The destruction of ozone by nitrogen oxides, substantially present in urban areas, is the reason for the lower ozone concentrations in southern Ontario.

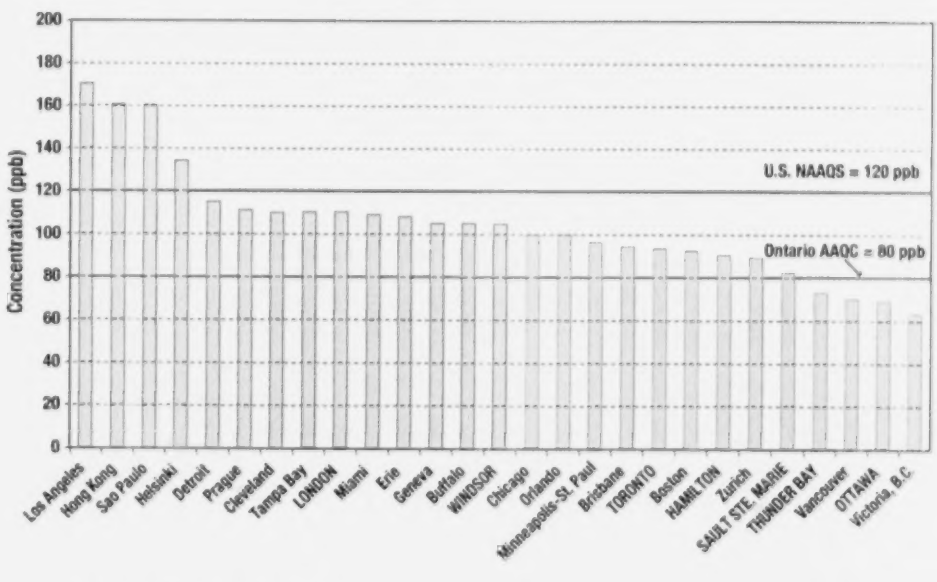
In Figure 2.8, the ozone monthly means are compared in southern and northern Ontario for 1990 to 2001. The ozone monthly mean concentrations are higher in northern Ontario during the cooler months of the year. For the month of February, ozone mean concentrations in the north are approximately 11 ppb greater than those observed in the south. Since local emissions of nitrogen oxides are lower in the northern sites, there is less removal of ozone than in southern urban areas. There is also greater potential for stratospheric ozone to be mixed into the troposphere in northern Ontario during late winter and early spring. During the summer months, ozone and its precursors are transported into southern Ontario from the mid-western U.S. causing ozone levels to rise in southern Ontario as well.

International perspective

In Figure 2.9, ozone one-hour maximum concentrations are displayed for 27 selected cities for the year 2000. The highest one-hour ozone concentration during 2000 was recorded in Los Angeles (170 ppb), followed closely by Hong Kong (160 ppb) and Sao Paulo, Brazil (160 ppb). Toronto's ozone one-hour maximum concentration (93 ppb) ranked 9th best out of 27 cities in 2000. Victoria, British Columbia recorded the lowest ozone maximum at only 63 ppb. Thunder Bay, Vancouver, Ottawa and Victoria were the only cities that did not exceed Ontario's one-hour AAQC of 80 ppb.

The range of ozone one-hour maximum concentrations and the 10-year means of the one-hour maximums for the period 1991 to 2000 are displayed for 27 cities from around the world in Figure 2.10. Los Angeles

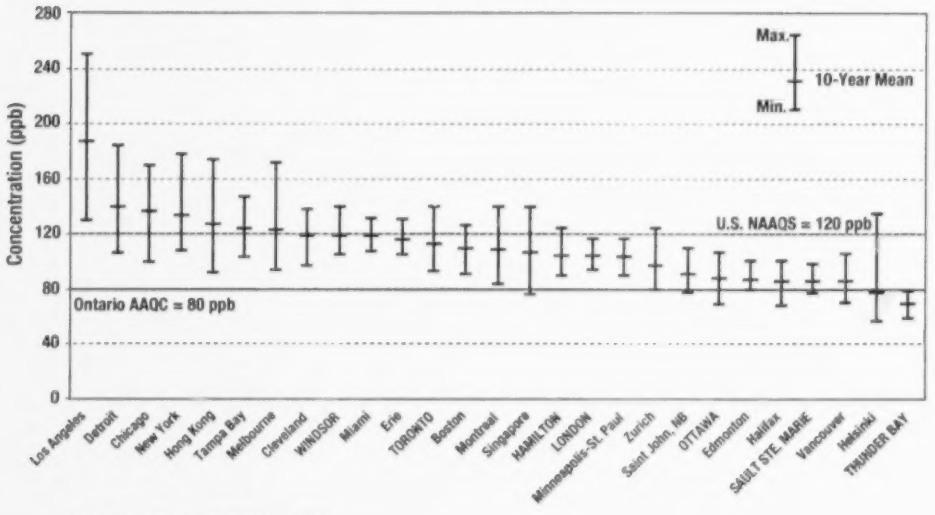
Figure 2.9
Ozone One-Hour Maximum Concentrations in Selected Cities (2000)



Note: Ontario cities are in CAPITALS.

recorded the highest 10-year mean based on the ozone one-hour maximum concentration, while Thunder Bay had the lowest. Over the 10-year period, Toronto ranked 16th best out of the 27 cities for ozone one-hour maximum concentrations. Overall, 18 of the 27 cities studied here exceeded the U.S. National Ambient Air Quality Standard (NAAQS) of 120 ppb during at least one year. Thunder Bay was the only city that did not exceed Ontario's AAQC at any time during the ten-year period.

Figure 2.10
Range of Ozone One-Hour Maximum Concentrations in Selected Cities (1991 - 2000)



Note: Ontario cities are in CAPITALS.

Fine Particulate Matter

Particulate matter is the general term used to describe a mixture of microscopic solid particles in air. Particulate matter is characterised according to size – mainly because of the different health effects associated with particles of different diameters. Fine particulate matter refers to particles that are 2.5 microns in diameter and less. Also known as $PM_{2.5}$ or respirable particles, fine particulate matter penetrates the respiratory system further than larger particles.

Particles originate from many different stationary and mobile sources, as well as from natural sources. They may be emitted directly from a source or formed in the atmosphere by the transformation of gaseous emissions. This chapter discusses the ambient monitoring results from the $PM_{2.5}$ monitoring network.

Characteristics, sources and effects

Particulate matter includes aerosols, smoke, fumes, dust, fly ash and pollen. Its composition varies with origin, monitoring location, time of year, and atmospheric conditions. Fine

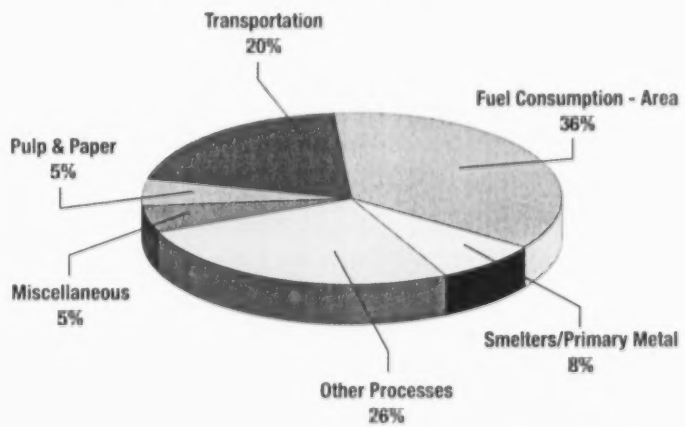
particulate matter is primarily formed from chemical reactions in the atmosphere and through fuel combustion (e.g. motor vehicles, power generation, industrial facilities, residential fireplaces and wood stoves, agricultural burning and forest fires). Significant amounts of $PM_{2.5}$ and its precursors are carried into Ontario from the U.S. Fine particulate matter can also be formed in the atmosphere through a series of complex chemical reactions and therefore, it is considered to be a secondary pollutant. During periods of widespread elevated levels of $PM_{2.5}$, it is estimated that more than 50 per cent of the pollutant in Ontario comes from the U.S. The U.S. contribution to $PM_{2.5}$ measurements in border cities is estimated to be as high as 90 per cent.

Figure 3.1 shows estimates by sector of Ontario's $PM_{2.5}$ emissions from area/point/mobile sources. Fuel combustion accounted for approximately 36 per cent of $PM_{2.5}$ emissions during 2001.

The greatest effect on health is from particles 2.5 microns or less in diameter. Exposure to $PM_{2.5}$ is associated with hospital admissions and several serious health effects, including premature death. People with asthma, cardiovascular or lung disease, as well as children and elderly people, are considered to be the most sensitive to the effects of $PM_{2.5}$. Adverse health effects have been associated with exposure to $PM_{2.5}$ during both short periods, such as a day, and longer periods of a year or more. Fine particulate matter is also responsible for environmental impacts such as corrosion, soiling, damage to vegetation and reduced visibility.

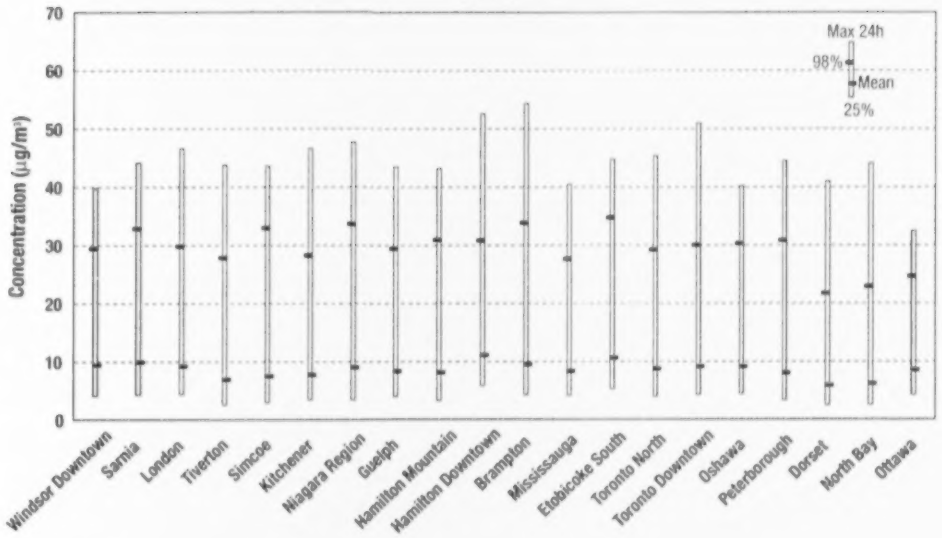
In 2000, the Canadian Council of Ministers of the Environment (CCME) developed a Canada-Wide Standard (CWS) for $PM_{2.5}$ as a result of the pollutant's adverse effects on human health and the environment. As referenced in the Guidance Document on Achievement Determination, the CWS for $PM_{2.5}$ is 30 micrograms per cubic metre ($\mu g/m^3$), based on the 98th percentile ambient measurement annually averaged over three consecutive years. Jurisdictions are required to meet the CWS for $PM_{2.5}$ by year 2011. Reporting on the CWS for $PM_{2.5}$ commences in 2006, hence, the following discussion and analysis mainly focuses on the examination of $PM_{2.5}$ 98th percentiles across Ontario as would be required.

Figure 3.1
Ontario $PM_{2.5}$ Emissions by Sector
(Emissions From Area/Point/Mobile Sources, 2001 Estimates)



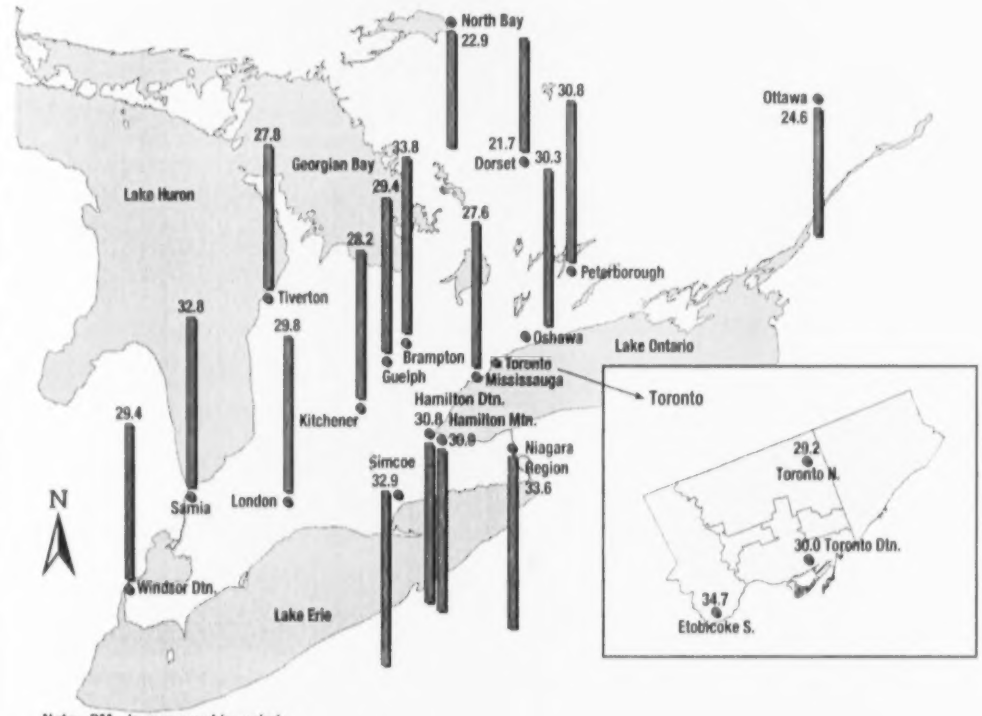
Note: 1. Emissions from open sources (such as construction activity, agricultural activity, road dust) are not included; Emissions from open sources from the smelters are not available.
2. Emission data are a combination of reported and projected emission estimates which may be revised with updated source/sector information or emission estimation methodologies as they become available.

Figure 3.2
Annual Statistics for 24-Hour $PM_{2.5}$ as Measured by TEOM in Ontario (2001)



Note: Data from ambient sites;
TEOM-Tapered Element Oscillating Microbalance.

Figure 3.3
Geographical Distribution of 24-Hour $PM_{2.5}$ Across Ontario (2001)



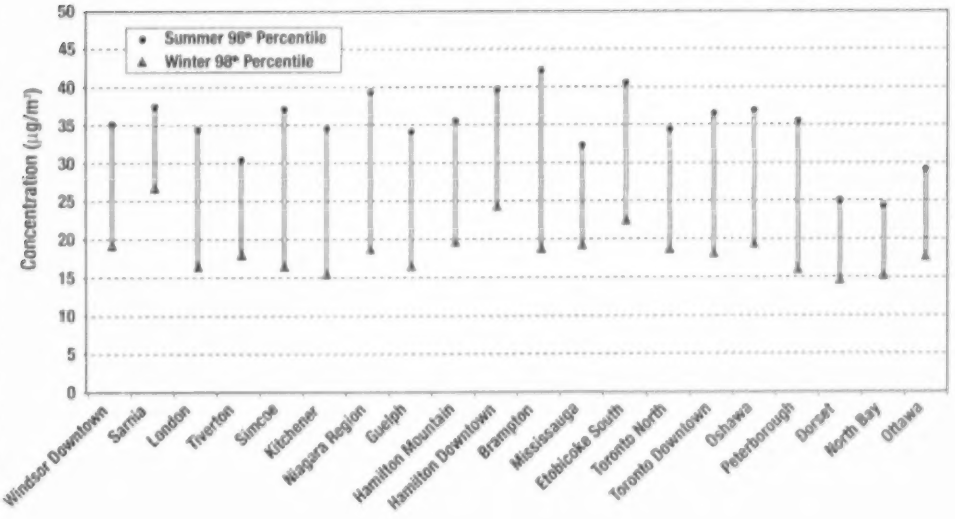
Note: $PM_{2.5}$ is measured in µg/m³;
Concentrations displayed are 98th percentiles.

Monitoring results in 2001

In 2001, continuous monitoring for $PM_{2.5}$ was conducted at 23 ambient monitoring locations; 20 sites had sufficient data to be used in the analysis presented here. The annual mean concentrations ranged from 5.9 µg/m³ in Dorset to a maximum of 11.1 µg/m³ in downtown Hamilton. The highest 24-hour average (54.4 µg/m³) was recorded at the Brampton site (Figure 3.2). The provincial ambient average for $PM_{2.5}$ during 2001 was 8.6 µg/m³. During 2001, the 98th percentile exceeded 30 µg/m³ at nine of the 20 ambient sites. The geographical distribution of $PM_{2.5}$ 98th percentiles for 2001 at sites across Ontario is shown in Figure 3.3. The 98th percentiles ranged from 21.7 µg/m³ in Dorset to 34.7 µg/m³ at the Etobicoke South site.

The seasonal variability of $PM_{2.5}$ is more distinct when comparing the summer/winter 98th percentiles for the 20 ambient sites during 2001 (Figure 3.4). The 98th percentiles in the summer months are greater than the 98th percentiles in the winter months. Brampton recorded the highest 98th percentile (42.6 µg/m³) during the summer months and Sarnia recorded the highest 98th percentile (26.6 µg/m³) during the winter months. The lowest 98th percentiles were recorded at North Bay (23.9 µg/m³) during the summer and Dorset (14.5 µg/m³) during the winter.

Figure 3.4
Seasonal 24-Hour $PM_{2.5}$ at Sites Across Ontario (2001)



Note: Data from ambient sites;
Seasonal definitions - Summer (May to September); Winter (January to April, October to December).

Other Criteria Contaminants

Characteristics, sources and effects of sulphur dioxide (SO_2), nitrogen dioxide (NO_2), carbon monoxide (CO), total reduced sulphur (TRS) compounds and mercury (Hg) are discussed in this chapter, as well as their ambient concentrations for 2001 and trends over time from regional and international perspectives (where applicable). Their corresponding annual emission estimate trends are also discussed.

SULPHUR DIOXIDE

Characteristics, sources and effects

Sulphur dioxide (SO_2) is a colourless gas that smells like burnt matches. It can be oxidized to sulphur trioxide, which in the presence of water vapour is readily transformed to sulphuric acid mist. Sulphur dioxide can also be oxidized to form sulphuric acid aerosols. Sulphur dioxide is also a precursor to sulphates, which are one of the main components of fine particulate matter in the atmosphere.

Industrial sources of SO_2 include iron and steel mills, petroleum refineries, and pulp and paper mills. Lesser sources include residential, commercial and industrial space heating. Approximately 69 per cent of the SO_2 emitted in Ontario in 2001 came from smelters and utilities (Figure 4.1). The highest concentrations of SO_2 historically have been recorded in the vicinity of large, industrial facilities.

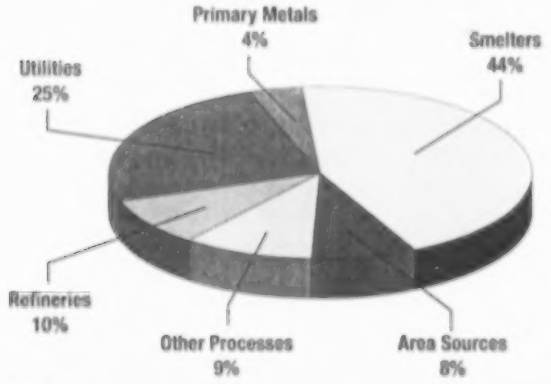
Health effects caused by exposure to high levels of SO_2 include breathing problems, respiratory illness, changes in the lung's defences, and worsening respiratory and cardiovascular disease. People with asthma, chronic lung disease or heart disease are the most sensitive to SO_2. Sulphur dioxide also damages trees and crops. Sulphur dioxide and NO_2 are the main precursors of acid rain, which contribute to the acidification of lakes and streams, accelerated corrosion of buildings, and reduced visibility. Sulphur dioxide also causes formation of microscopic acid aerosols, which have serious health implications and contribute to climate change.

Monitoring results for 2001

Sulphur dioxide was monitored at 25 ambient locations in 2001; 24 sites provided sufficient data to be used in the analysis

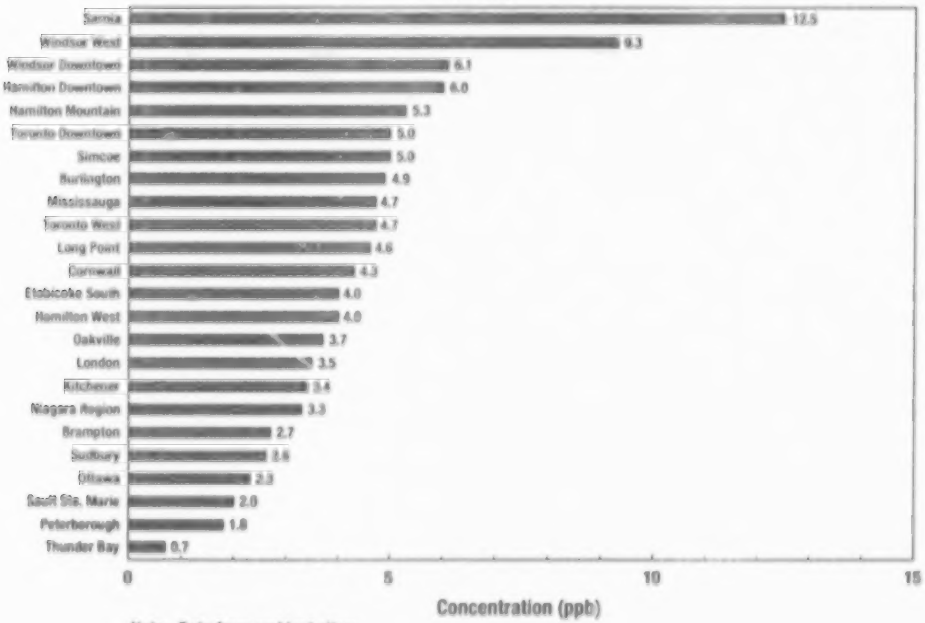
presented here. Sarnia recorded the highest annual mean (12.5 ppb) and 24-hour maximum concentration (131 ppb) during 2001. The provincial 24-hour criterion (100 ppb) for SO_2 was not exceeded at any ambient site with the exception of Sarnia, which exceeded on two occasions in 2001. Science North in Sudbury recorded the highest one-hour concentration (318 ppb). In 2001, Sarnia and the Science North site in Sudbury were the only ambient sites to record an instance above the SO_2 one-hour criterion of 250 ppb. The SO_2 one-hour

Figure 4.1
Ontario Sulphur Dioxide Emissions by Sector
(Emissions From Human Activity, 2001 Estimates)



Note: Emission data are a combination of reported and projected emission estimates which may be revised with updated source/sector information or emission estimation methodologies as they become available.

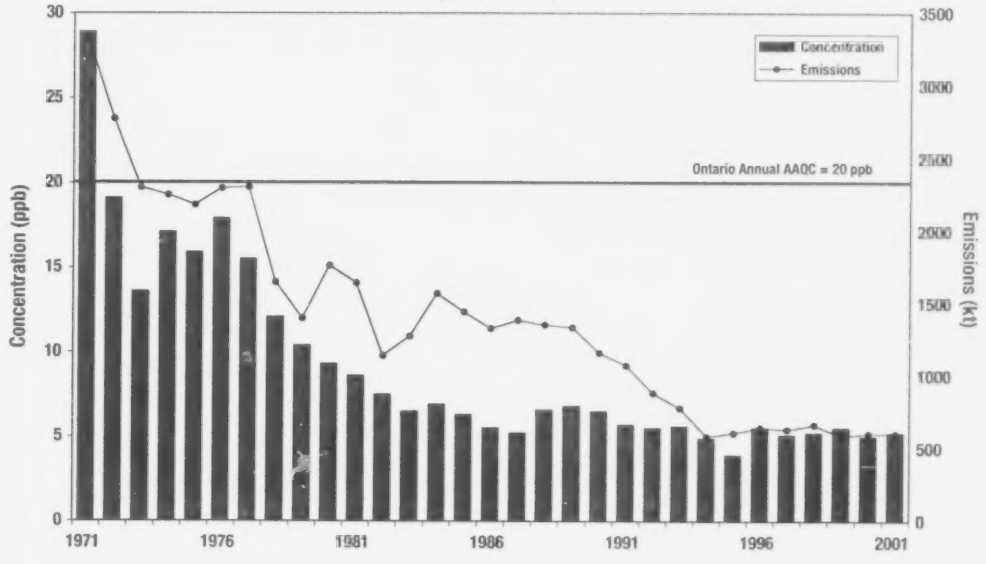
Figure 4.2
Sulphur Dioxide Annual Means Across Ontario
(2001)



Note: Data from ambient sites;
Ontario annual AAQC for sulphur dioxide is 20 ppb.

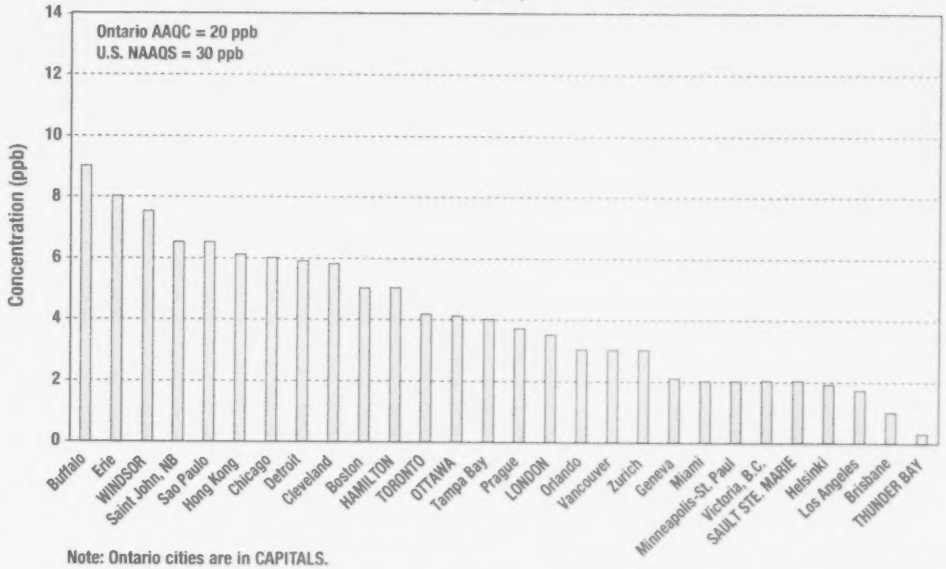
criterion was exceeded four times at the Science North site and one time at the Sarnia site. Figure 4.2 shows the SO_2 annual means at ambient sites across Ontario. Sarnia and Windsor recorded the highest annual mean in 2001. The annual levels across the province ranged from a low of 0.7 ppb in Thunder Bay to a high of 12.5 ppb in Sarnia. The annual criterion of 20 ppb for SO_2 was not exceeded at any site in Ontario during 2001.

Figure 4.3
31-Year Trend of Sulphur Dioxide Concentrations in Ontario
(1971 - 2001)



Note: Annual composite mean based on 11 ambient SO_2 sites operated over 31 years.

Figure 4.4
Sulphur Dioxide Annual Means in Selected Cities
(2000)

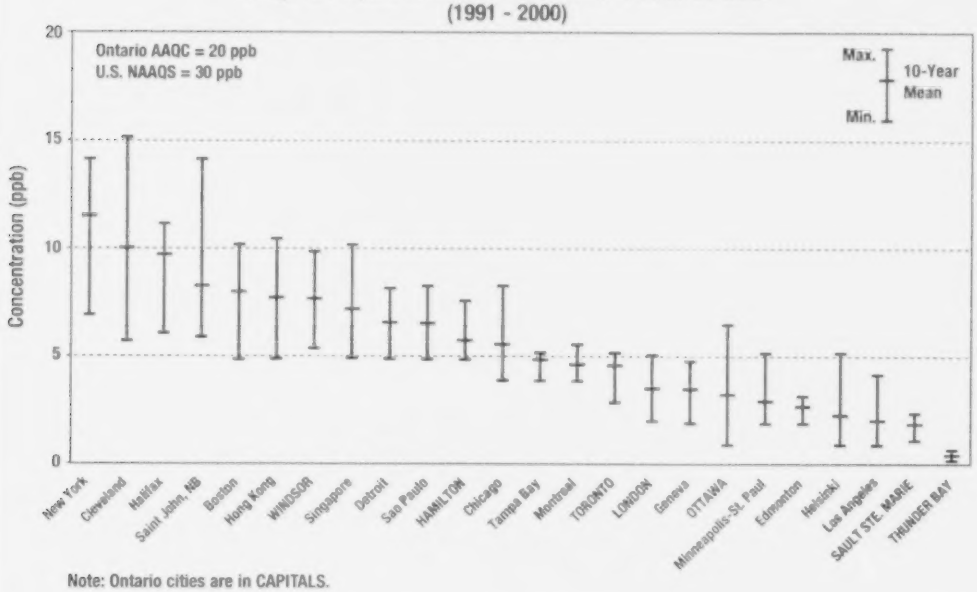


Note: Ontario cities are in CAPITALS.

Trends

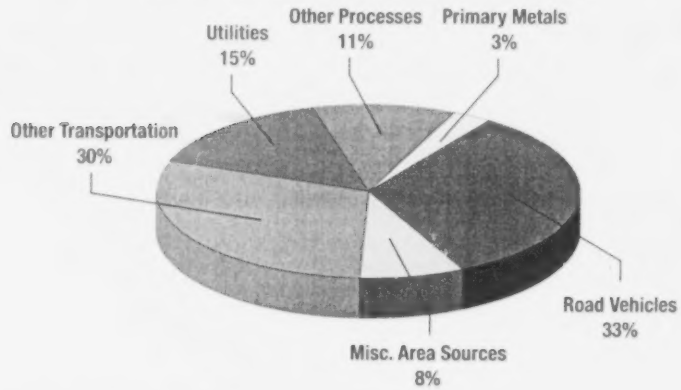
Over the long-term, 1971 to 2001, Ontario's SO_2 emissions decreased by 82 per cent, while average ambient SO_2 concentrations in the province improved by 82 per cent during the same period (Figure 4.3). Regulations 346 and 350, control orders on smelting operations and the Countdown Acid Rain program, resulted in significant decreases of SO_2 emissions in the early 1990s. In 1998, Algoma Steel Inc. closed down its operation in Wawa, Ontario, resulting in a reduction of SO_2 emissions from 1998 onwards. The introduction of low sulphur diesel fuel in the late 1990s also resulted in a decrease in sulphur dioxide emissions from the transportation sector. For example, the sulphur content in motor gasoline decreased from approximately 460 ppm in 2000 to 390 ppm in 2001. Over the

Figure 4.5
Range of Sulphur Dioxide Annual Means in Selected Cities
(1991 - 2000)



Note: Ontario cities are in CAPITALS.

Figure 4.6
Ontario Nitrogen Oxides Emissions by Sector
(Emissions From Human Activity, 2001 Estimates)



Note: Emission data are a combination of reported and projected emission estimates which may be revised with updated source/sector information or emission estimation methodologies as they become available.

10-year period from 1992 to 2001, sulphur dioxide concentrations decreased by five per cent.

International Perspective

Annual means of SO_2 concentrations for 2000 are shown for 28 cities in Figure 4.4. In 2000, the highest annual mean (9 ppb) was recorded in Buffalo, while Thunder Bay recorded the lowest annual mean (1 ppb). Toronto's annual SO_2 mean for the year 2000 ranked 17th out of the 28 cities. All of the cities recorded levels below Ontario's annual AAQC of 20 ppb and the U.S. NAAQS of 30 ppb.

The range of the annual means and the 10-year average of the means for SO_2 concentrations from 1991 to 2000 are displayed in Figure 4.5 for 24 selected cities around the world. New York had the highest 10-year mean for SO_2 concentrations, while Thunder Bay had the lowest. Toronto ranked 10th best out of the 24 cities compared.

NITROGEN DIOXIDE

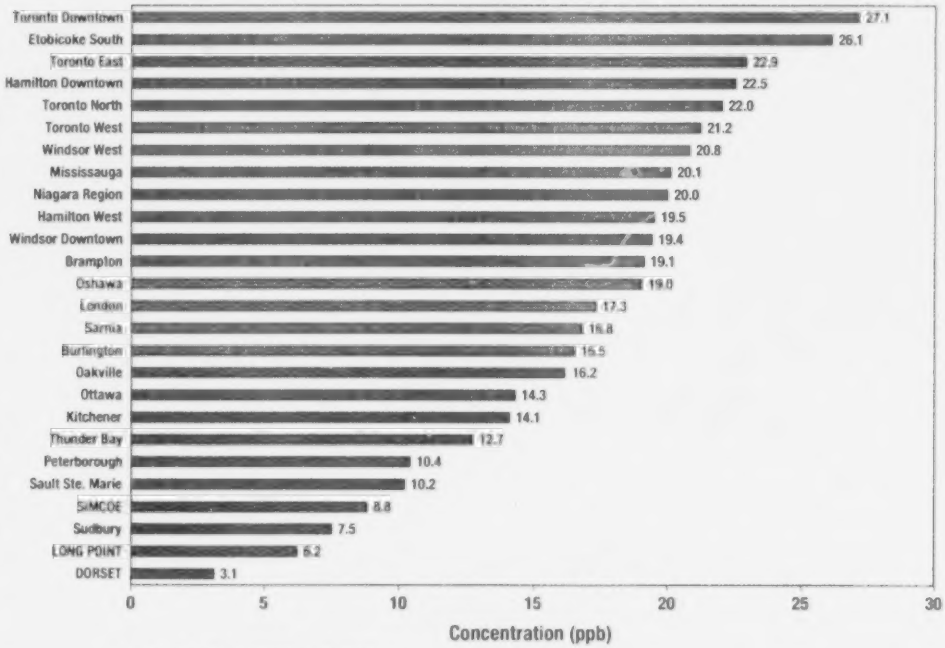
Characteristics, sources and effects

Nitrogen dioxide (NO_2) is a reddish-brown gas with a pungent and irritating odour, which transforms in the air to form gaseous nitric acid and organic nitrates. It also plays a major role in atmospheric reactions that produce ground-level ozone, a major component of smog. Nitrogen dioxide is also a precursor to nitrates, which contribute to levels of fine particulate matter in the atmosphere.

All combustion in air produces nitrogen oxides (NO_x), of which NO_2 is a major component. Natural sources of NO_x include lightning and the aerobic activity of soil bacteria. Approximately 63 per cent of NO_x in Ontario in 2001 were emitted from the transportation sector (Figure 4.6). A large part of the remaining 37 per cent of NO_x emissions came from fossil fuel power generation, primary metal production and incineration.

Nitrogen dioxide can irritate the lungs and lower resistance to respiratory infection. People with asthma and bronchitis

Figure 4.7
Nitrogen Dioxide Annual Means Across Ontario (2001)



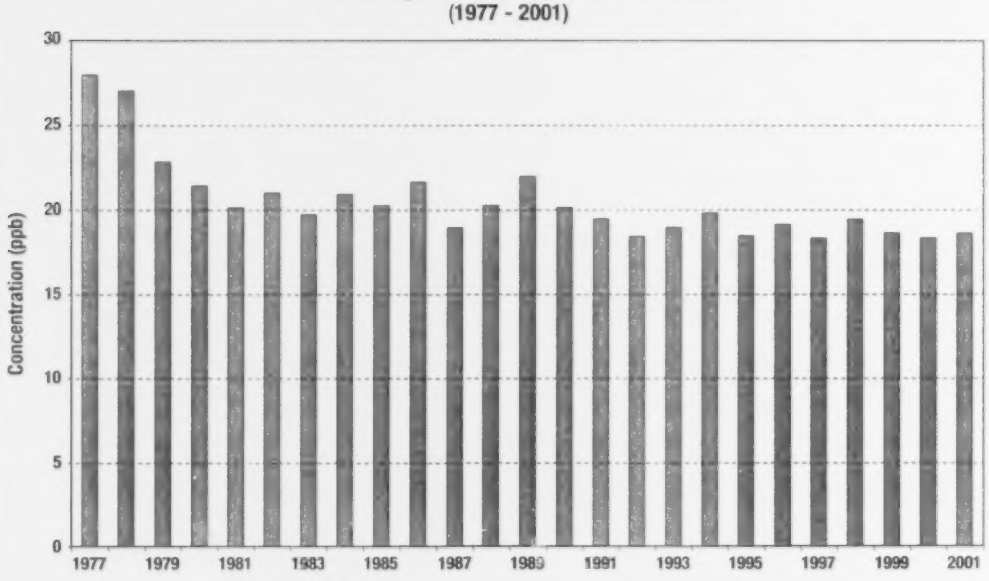
Note: Rural sites are in CAPITALS;
Data from ambient sites.

have increased sensitivity. Nitrogen dioxide chemically transforms into nitric acid in the atmosphere and, when deposited, contributes to lake acidification. Nitric acid can also corrode metals, fade fabrics, degrade rubber, and damage trees and crops.

Monitoring results for 2001

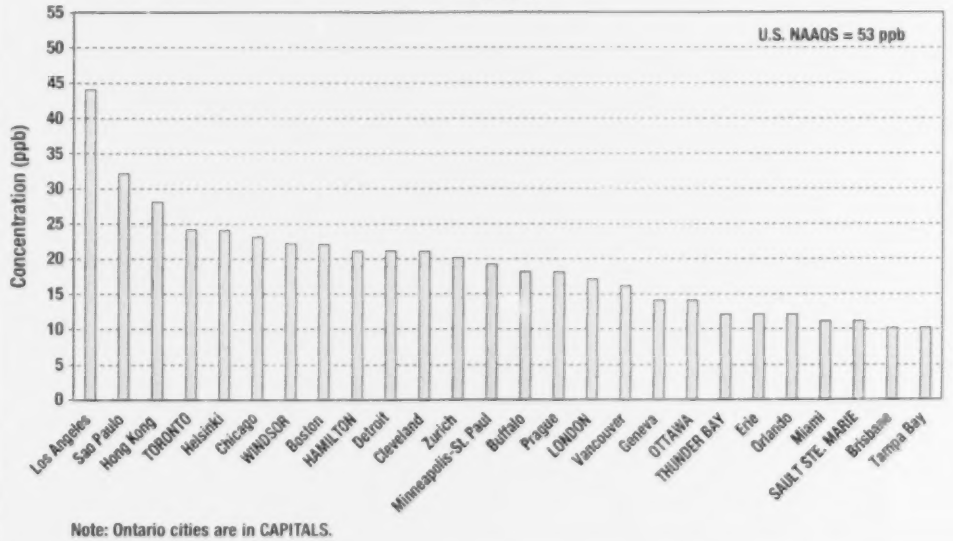
Monitoring for NO_2 was performed at 31 ambient locations in 2001; 26 sites provided sufficient data to be used in the analysis presented here. Nitrogen dioxide annual means across Ontario are displayed in Figure 4.7.

Figure 4.8
Trend of Nitrogen Dioxide Annual Means in Ontario
(1977 - 2001)



Note: Annual composite mean based on 14 ambient sites operated over 25 years.

Figure 4.9
Nitrogen Dioxide Annual Means in Selected Cities
(2000)



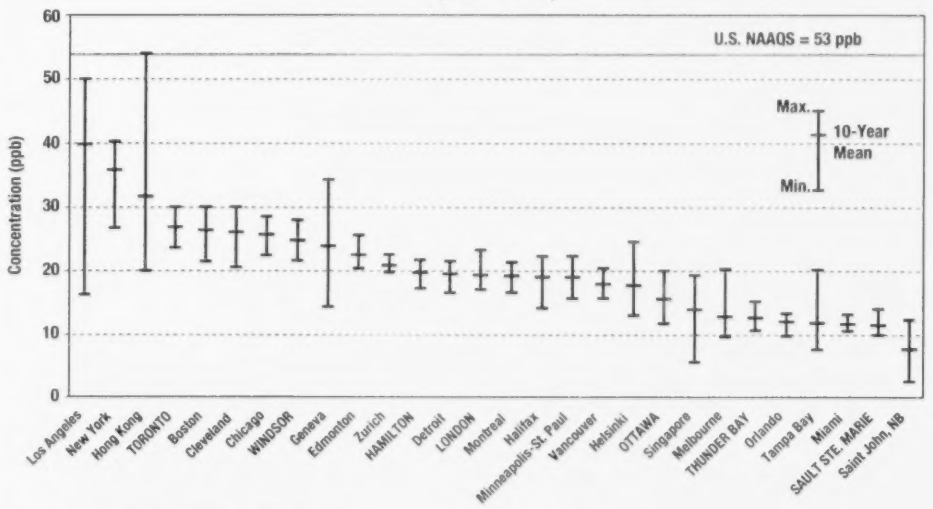
Note: Ontario cities are in CAPITALS.

Downtown Toronto recorded the highest annual mean (27.1 ppb) during 2001. Typically, the highest NO_2 means are recorded in larger urban centres, such as the Greater Toronto Area (GTA) and the Golden Horseshoe area of southern Ontario. The Niagara Region air station recorded the highest 24-hour concentration (78 ppb) in 2001, whereas the Etobicoke South site recorded the highest one-hour concentration (197 ppb). During 2001, Ontario's 24-hour criterion of 100 ppb for NO_2 and one-hour criterion of 200 ppb were not exceeded at any of the 26 monitoring locations.

Trends

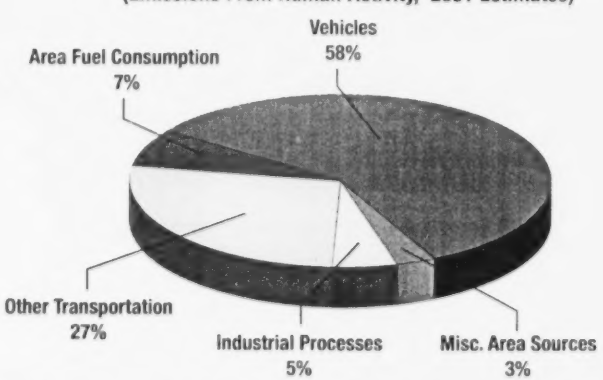
Provincial average ambient NO_2 concentrations show a decreasing trend for the period 1977 to 2001 (Figure 4.8). Average concentrations in 2001 were 33 per cent lower than the levels recorded in 1977. During the 10-year period of 1992 to 2001, the annual means for NO_2 do not show a trend; however, they were all below 20 ppb.

Figure 4.10
Range of Nitrogen Dioxide Annual Means in Selected Cities
(1991 - 2000)



Note: Ontario cities are in CAPITALS.

Figure 4.11
Ontario Carbon Monoxide Emissions by Sector
(Emissions From Human Activity, 2001 Estimates)



Note: Emission data are a combination of reported and projected emission estimates which may be revised with updated source/sector information or emission estimation methodologies as they become available.

International perspective

Annual means of NO_2 concentrations for 2000 are shown for 26 cities in Figure 4.9. Los Angeles (44 ppb), Sao Paulo (32 ppb) and Hong Kong (28 ppb) recorded the highest NO_2 annual means for 2000, while Brisbane and Tampa Bay both recorded the lowest mean of 10 ppb. Toronto's annual NO_2 mean (24 ppb) ranked 23rd out of the 26 cities – far below the U.S. NAAQS for NO_2 (53 ppb) during 2000.

The range of the annual means and the 10-year average of the means for NO_2 concentrations for 1991-2000 are displayed in Figure 4.10 for 28 selected cities worldwide. Los Angeles recorded the highest 10-year mean, while Saint John, New Brunswick recorded the lowest. Toronto ranked 25th out of the 28 cities compared.

CARBON MONOXIDE

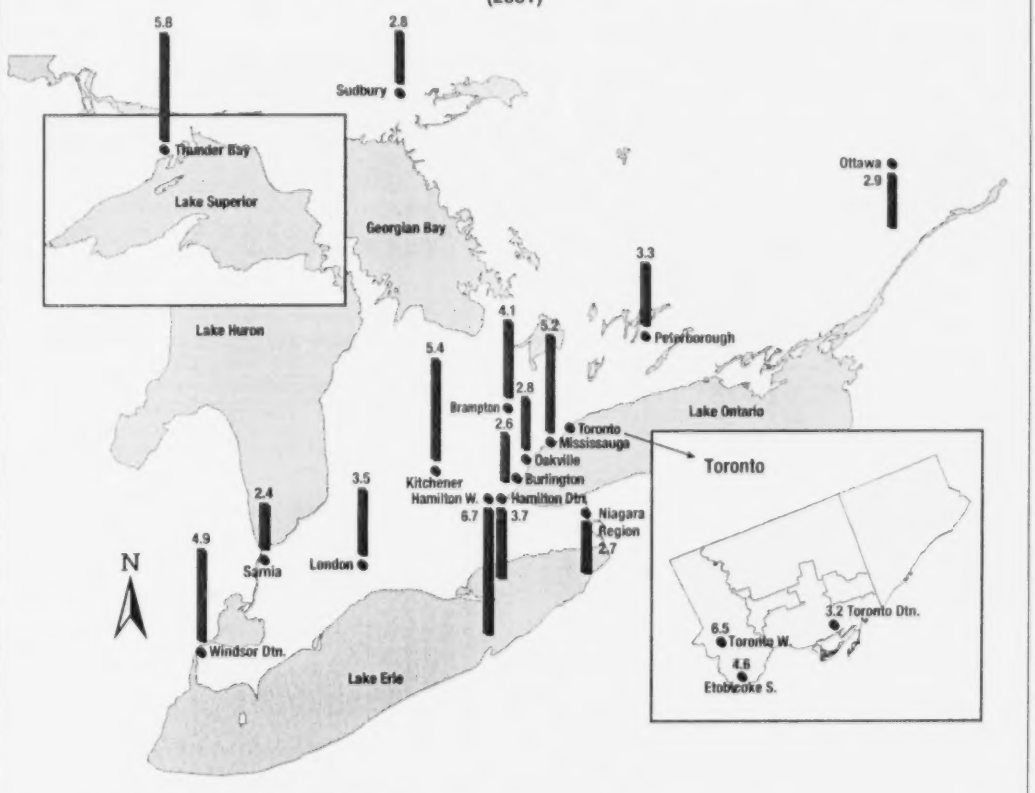
Characteristics, sources and effects

Carbon monoxide is a colourless, odourless, tasteless and, at high concentrations, a poisonous gas produced primarily by incomplete combustion of fossil fuels. The transportation sector accounted for 85 per cent of all CO emissions from human activity in Ontario during 2001 (Figure 4.11). Carbon monoxide enters the bloodstream and reduces oxygen delivery to the organs and tissues. People with heart disease are particularly sensitive. Exposure to high levels is linked with the impairment of vision, work capacity, learning ability and performance of complex tasks.

Monitoring results for 2001

Monitoring for CO was performed at 20 ambient locations in 2001; 18 sites provided sufficient data to be used in the analysis

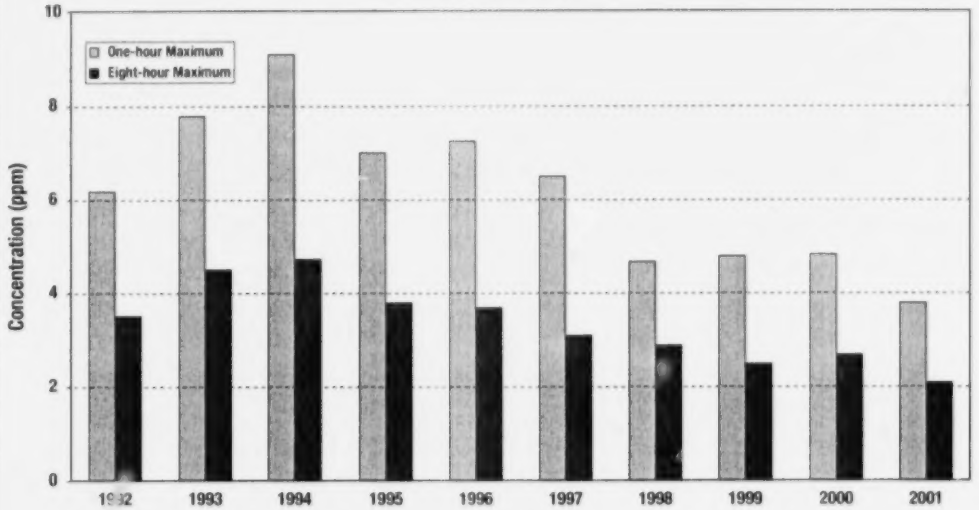
Figure 4.12
Geographical Distribution of Carbon Monoxide One-Hour Maximum Concentrations Across Ontario (2001)



Note: One-hour Ontario AAQC = 30 ppm;
Carbon monoxide concentrations are reported in parts per million (ppm).

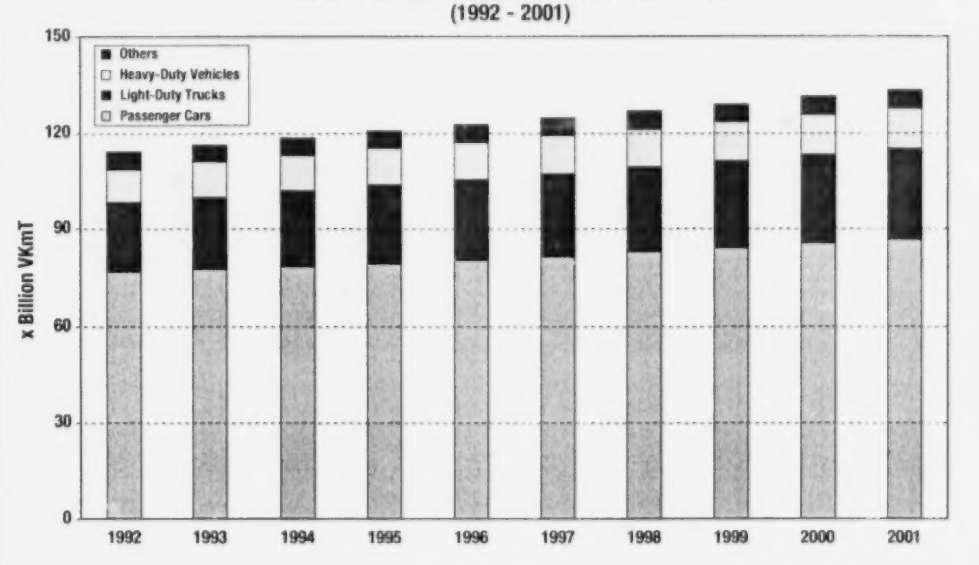
presented here. In 2001, the highest annual mean was 1.0 part per million (ppm), which was recorded at the Toronto West site. This site also recorded the highest eight-hour maximum value (4.2 ppm). The highest one-hour maximum CO value (6.7 ppm) was measured at the Hamilton West site (Figure 4.12). The highest CO concentrations are recorded typically in larger urban centres as a result of vehicle emissions. Ontario's one-hour (30 ppm) and

Figure 4.13
Trend of Carbon Monoxide One-Hour and Eight-Hour Maximums in Ontario
(1992 - 2001)



Note: Data is based on 15 ambient CO sites operated over 10 years;
Ontario's one-hour AAQC = 30 ppm;
Ontario's eight-hour AAQC = 13 ppm.

Figure 4.14
Trend of Vehicle-Kilometres Travelled in Ontario
(1992 - 2001)



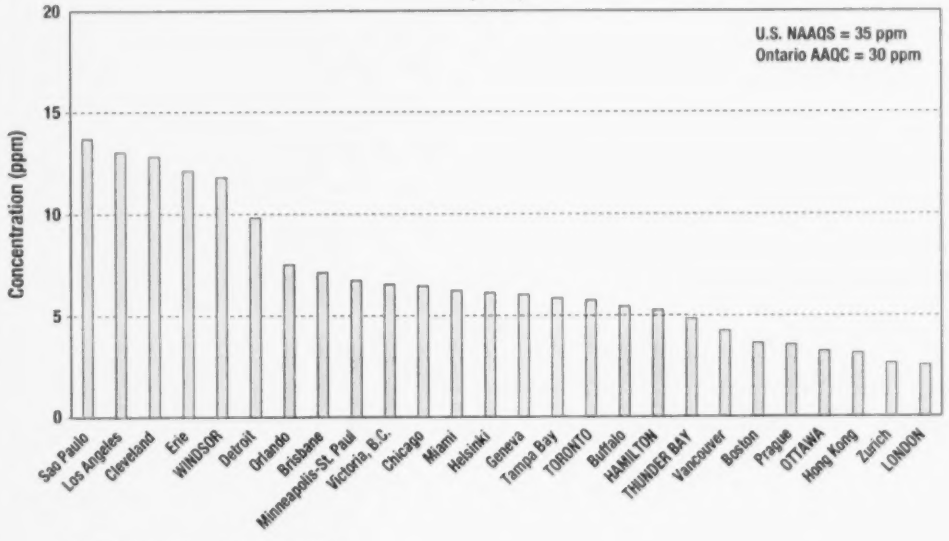
Note: VKmT represents vehicle-kilometres travelled.

eight-hour (13 ppm) ambient air quality criteria for CO have not been exceeded at any of the monitoring sites in Ontario since 1991.

Trends

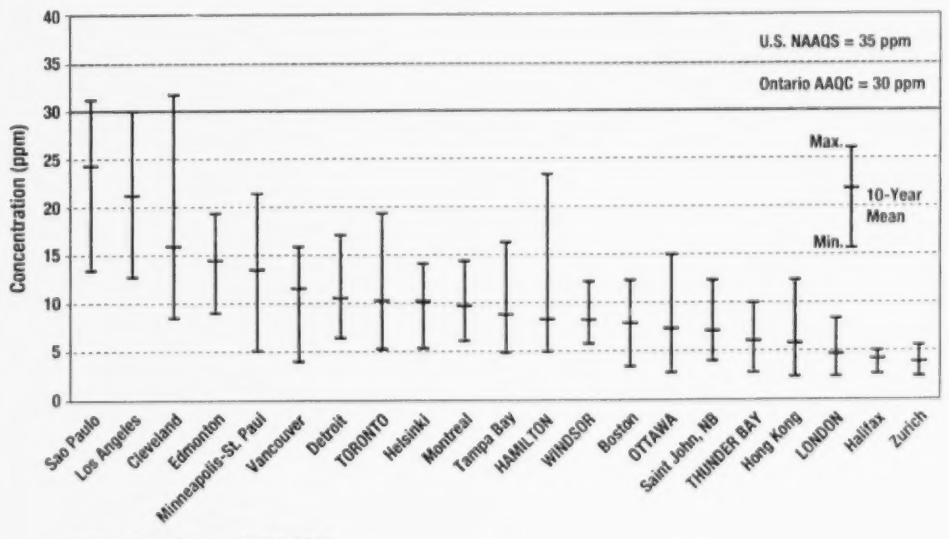
The trends in provincial averaged one-hour and eight-hour maximum CO concentrations for 1992 to 2001 are shown in Figure 4.13. Over this 10-year period, ambient CO concentrations as measured by the composite average of the one and eight-hour maximums decreased by 39 and 40 per cent, respectively. The CO composite

Figure 4.15
Carbon Monoxide One-Hour Maximum Concentrations in Selected Cities (2000)



Note: Ontario cities are in CAPITALS.

Figure 4.16
Range of Carbon Monoxide One-Hour Maximum Concentrations in Selected Cities (1991 - 2000)



Note: Ontario cities are in CAPITALS.

annual mean in 2001 was 29 per cent less than the corresponding 1992 composite mean. These reductions in ambient CO levels have occurred despite a 17 per cent increase in vehicle-kilometres travelled over the same 10-year period (Figure 4.14). Carbon monoxide concentrations also improved by 85 per cent from 1971 to 2001.

International perspective

Carbon monoxide one-hour maximum concentrations for 2000 are displayed for 26 cities in Figure 4.15. Sao Paulo recorded the highest CO one-hour concentration (13.7 ppm) in 2000, while London recorded the lowest CO maximum (2.5 ppm). Internationally, Toronto ranked 11th out of the 26 cities in 2000. Overall, all concentrations remained well below the Ontario AAQC of 30 ppm and the U.S. NAAQS of 35 ppm.

The range of CO one-hour maximum concentrations and the 10-year means of the one-hour maximums for 1991-2000 are displayed in Figure 4.16 for 21 selected cities from around the world. Sao Paulo recorded the highest 10-year mean based on CO one-hour maximum concentrations. Sao Paulo and Cleveland exceeded the more restrictive one-hour Ontario AAQC during at least one year, however, neither of the sites exceeded the one-hour U.S. NAAQS. Zurich and Halifax had the smallest range of one-hour maximums, which did not exceed 6 ppm at any time during the period of study. Toronto ranked 14th out of the 21 cities when comparing the 10-year mean of the CO one-hour maximum concentrations. Toronto did not exceed the Ontario AAQC or the U.S. NAAQS from 1991 to 2000.

TOTAL REDUCED SULPHUR COMPOUNDS

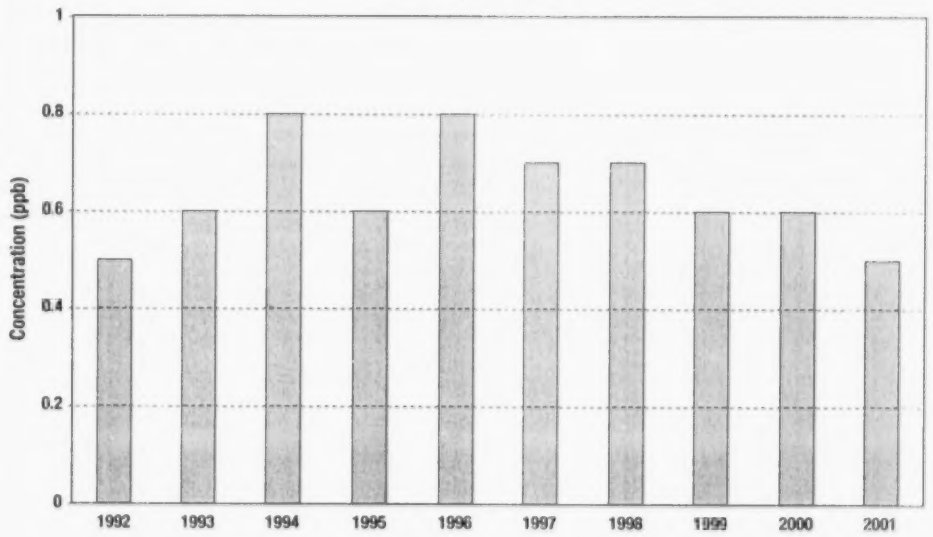
Characteristics, sources and effects

Total reduced sulphur (TRS) compounds produce an offensive odour similar to rotten eggs or cabbage.

Industrial sources of TRS compounds include the steel industry, pulp and paper mills, refineries and sewage treatment facilities. Natural sources include swamps, bogs and marshes.

TRS compounds are not normally considered a health hazard. They are, however, a

Figure 4.17
Trend of TRS Annual Means in Ontario
(1992 - 2001)



Note: Annual composite mean based on 10 ambient TRS sites operated over 10 years.

primary cause of odours at some locations in the province.

Monitoring results for 2001
Monitoring for TRS compounds was performed at nine ambient locations in 2001. The highest TRS mean (1.0 ppb) was recorded at the Windsor West air monitoring site. This is also where the greatest number of hours (six) above the AAQC of 27 ppb was recorded. The maximum one-hour concentration (62 ppb) was measured in downtown Hamilton.

Trends
The 10-year trend in provincial TRS annual mean concentrations at ambient monitoring sites is shown in Figure 4.17. Provincial means of ambient TRS levels show a decreasing trend since 1996.

MERCURY

Characteristics, sources and effects
Mercury (Hg) is unique, as it is the only metal that is a liquid at room temperature. It is probably best known as the silver liquid in thermometers.

Mercury is of concern as an environmental contaminant because of its ability to accumulate in living organisms, potentially reaching concentrations that could pose a hazard to health in humans and wildlife. The accumulation of mercury in the aquatic food chain results in relatively high levels of mercury in fish consumed by humans. Although mercury has been recognised as an environmental pollutant for decades, relatively limited monitoring for the assessment and behaviour of mercury in the atmosphere has taken place.

Mercury sources include incinerators and coal and oil-fired generating stations. Mercury also occurs naturally in the environment as mercuric sulphide.

Potential health effects resulting from exposure to mercury include leukaemia and other cancers, reproductive and developmental effects, such as impaired development in newborn and young children, and damage to the pulmonary system. Effects of mercury on the aquatic ecosystem are of particular concern as levels bio-accumulate in animals at the top of the food chain resulting in exposure many times higher than directly from water or air.

Monitoring results for 2001
Continuous air monitoring for elemental mercury is relatively new to Ontario's provincial air monitoring network. Monitoring for mercury began in 2000 at two locations – Toronto West and Mississauga. During 2001, the maximum one-hour Hg readings at Toronto West and Mississauga were 48 ng/m^3 and 47 ng/m^3 respectively. These concentrations are well below the provincial one-hour guideline of 5,000 ng/m^3.

During 2001, ambient annual mean concentrations of mercury were just over 2 ng/m^3 at both monitoring locations.

Air Quality Index, Smog Alerts and 2001 Smog Episodes

Air Quality Indices (AQI)

The Ministry of the Environment operates an extensive network of air quality monitoring sites across the province. In 2001, 35 of these sites in 22 urban centres and seven rural areas formed the basis of the Air Quality Index (AQI) network. This included a new monitoring site in Parry Sound. The Air Quality Office at the Environmental Monitoring and Reporting Branch continually obtains data for several criteria pollutants from these 35 sites.

The AQI network, shown in Figure 5.1, provides the public with real-time air quality

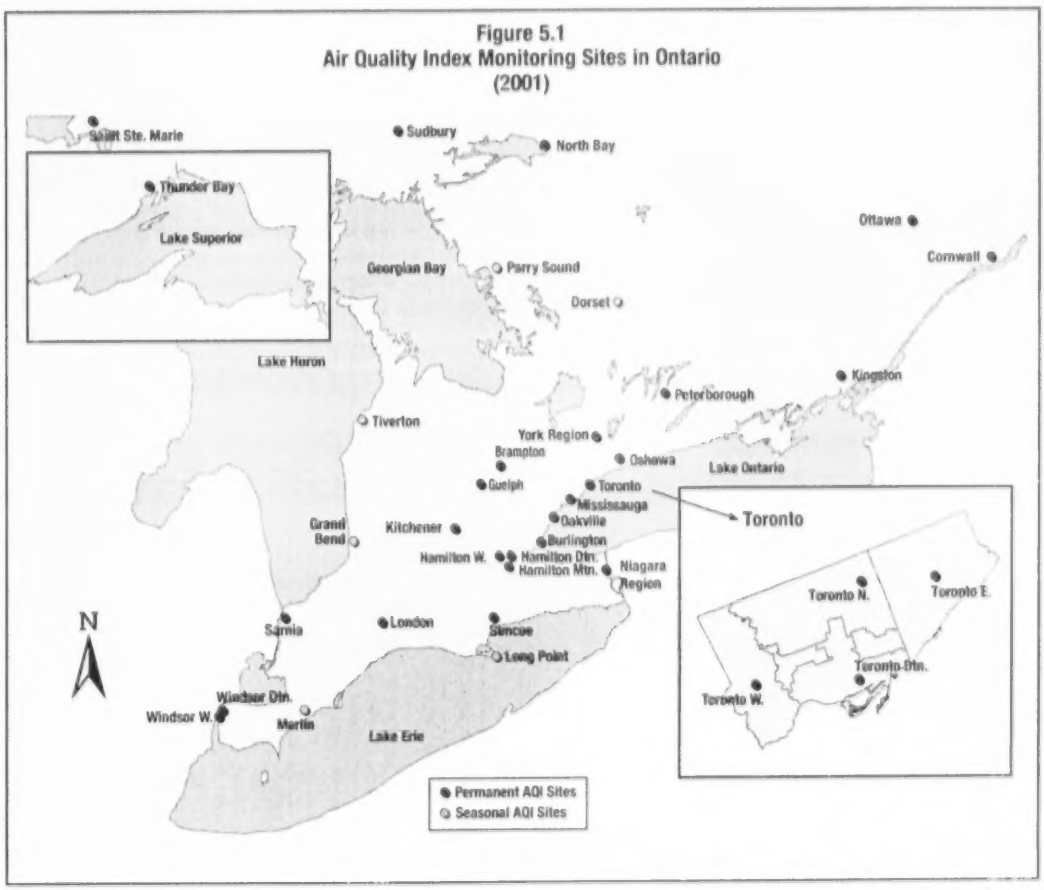
information across the province. The AQI is based on pollutants that have adverse effects on human health and the environment. The pollutants are sulphur dioxide (SO_2), ozone (O_3), nitrogen dioxide (NO_2), total reduced sulphur (TRS) compounds, carbon monoxide (CO) and suspended particles (SP) measured as the coefficient of haze (COH). At the end of each hour, the concentration of each pollutant measured at a particular site is converted into a number that ranges from zero upwards using a common scale or index. The calculated number for each pollutant is called a sub-index.

At a given site, the highest sub-index for any given hour becomes the AQI. The lower the index, the better the air quality. The index values, corresponding categories and potential health and environmental effects are shown in Table 5.1.

If the AQI value is below 32, the air quality is considered good. For AQI values in the 32-49 range (moderate category) there may be some adverse effects on very sensitive people. For index values in the 50-99 range (poor category), the air quality may have adverse effects on sensitive members of human and animal populations, and may cause significant damage to vegetation and property. With an AQI value of 100 or more (very poor category), the air quality may cause adverse effects for a large proportion of those exposed.

Computed air quality indices, or AQI values, and air quality forecasts are released daily to the public and news media at set intervals. The public can access the index values by calling the ministry's automatic telephone answering device (ATAD), English recording: 1-800-387-7768, or in Toronto, 416-246-0411, and French recording: 1-800-221-8852. The AQI values can also be obtained from the ministry's Web site: www.airqualityontario.com. Air

Figure 5.1
Air Quality Index Monitoring Sites in Ontario (2001)



quality forecasts based on regional meteorological conditions and current pollutant levels in Ontario and bordering U.S. states, are provided daily on this Web site.

Table 5.2 shows the percentage distribution of hourly AQI values for monitoring sites which operated all year round. This table displays the descriptive category and the pollutant responsible for the AQI above 31. All of the AQI sites in 2001 reported air quality in the good to very good category most often.

Figure 5.2 shows the composite pie diagrams of the percentages of very good, good, moderate and poor air quality recorded at sites across the province. The pie diagram on the left shows category percentages. The bar graph on the right breaks down the poor air quality shown in the pie diagram by the percentage of pollutants associated with the AQI above 100. Poor air quality at the majority of the AQI sites was due mainly to ozone. This pollutant accounted for approximately 81 percent of the number of poor air quality hours recorded during 2001 at the AQI sites. TRS accounted for approximately one-per cent of the poor air quality values.

Air Pollution Index (API)

The Air Pollution Index (API) continues to be the focus of an alert and control system aimed at deteriorating air quality. The Ontario Environmental Protection Act (1971) authorizes the Minister of the Environment to order any source that is essential to public health or safety to curtail or cease its operations when air pollution levels occur that may be injurious to health. The API is derived from 24 hour running averages of SO_2 and SP measured as the COH.

If the API reaches a value of 32 (designated as an Air Advisory Level) and adverse atmospheric

Table 5.1: Air Quality Index Pollutants and Their Impacts

Index	Category	Carbon Monoxide (CO)	Nitrogen Dioxide (NO_2)	Ozone (O_3)	Sulphur Dioxide (SO_2)	Suspended Particles (SP)	SO_2 + SP (As measured by the API)	Total Reduced Sulphur (TRS) Compounds
0-15	Very good	No known harmful effects	No known harmful effects	No known harmful effects	No known harmful effects	No known harmful effects	No known harmful effects	No known harmful effects
16-31	Good	No known harmful effects	Slight odour	No known harmful effects	Damages some vegetation in combination with ozone	No known harmful effects	No known harmful effects	Slight odour
32-49	Moderate	Risk mainly to fetus. Some effects on cigarette	Odour	Slight chest tightness, cough, throat irritation, eye irritation, reduced lung function in active persons on exercising	Some damage to vegetation	Low increase in visibility	Increased risk of symptoms in persons with lung or heart disease	Odour
50-99	Poor	Increased symptoms in persons with heart disease	Air smells and looks brown. Some increase in bronchial reactivity in people with asthma	Serious respiratory symptoms in those who exercise, and persons with lung disease when physically active; people with heart/lung disorders at greater risk. Damages some plants	Increasing sensitivity for people with asthma and bronchitis	Increased visibility reduction	Increased symptoms in persons with lung or heart disease	Strong odour
100-over	Very poor	Increasing symptoms in non-smokers with heart disease; blurred vision; some drowsiness	Increasing sensitivity for people with asthma and bronchitis	Serious respiratory effects, even during light physical activity; people with heart/lung disorders at high risk; more widespread damage	Increasing sensitivity for people with asthma and bronchitis	Increasing sensitivity for people with asthma and bronchitis	Significant effects for people with asthma and bronchitis	Severe odour; some people may experience nausea and headache

quality forecasts, based on regional meteorological conditions and current pollution levels in Ontario and bordering U.S. states, are provided daily on this Web site.

Table 5.2 shows the percentage distribution of hourly AQI values for monitoring sites which operated all year round. This table displays the descriptive category and the pollutant responsible for the AQI above 31. All of the AQI sites in 2001 reported air quality in the good to very good category most often.

Figure 5.2 shows the composite pie diagrams of the percentages of very good, good, moderate and poor air quality recorded at sites across the province. The pie diagram on the left shows category percentages. The diagram on the right breaks down the poor air quality slice into percentages of pollutants associated with the AQI above 49. Poor air quality at the majority of the AQI sites was due only to ozone. This pollutant accounted for approximately 99 per cent of the number of poor air quality hours recorded during 2001 at the AQI sites. TRS accounted for approximately one per cent of the poor air quality values.

Air Pollution Index (API)

The Air Pollution Index (API) continues to be the basis of an alert and control system to warn of deteriorating air quality. The Ontario Environmental Protection Act (1971) authorises the Minister of the Environment to order any source not essential to public health or safety to curtail or cease its operations when air pollution levels occur that may be injurious to health. The API is derived from 24-hour running averages of SO_2 and SP measured as the COH.

If the API reaches a value of 32 (designated as an Air Advisory Level) and adverse atmospheric

Table 5.1: Air Quality Index Pollutants and Their Impacts

Index	Category	Carbon Monoxide (CO)	Nitrogen Dioxide (NO_2)	Ozone (O_3)	Sulphur Dioxide (SO_2)	Suspended Particles (SP)	SO_2 + SP (As measured by the API)	Total Reduced Sulphur (TRS) Compounds
0-15	Very good	No known harmful effects	No known harmful effects	No known harmful effects	No known harmful effects	No known harmful effects	No known harmful effects	No known harmful effects
16-31	Good	No known harmful effects	Slight odour	No known harmful effects	Damages some vegetation in combination with ozone	No known harmful effects	No known harmful effects	Slight odour
32-49	Moderate	Blood chemistry changes, but no noticeable impairment	Odour	Respiratory irritation in sensitive people during vigorous exercise; people with heart/lung disorders at some risk; damages very sensitive plants	Damages some vegetation	Some decrease in visibility	Damages vegetation (i.e. tomatoes, white beans due to sulphur dioxide)	Odour
50-99	Poor	Increased symptoms in smokers with heart disease	Air smells and looks brown. Some increase in bronchial reactivity in people with asthma	Sensitive people may experience irritation when breathing and possible lung damage when physically active; people with heart/lung disorders at greater risk; damages some plants	Odourous; increasing vegetation damage	Decreased visibility; soiling evident	Increased symptoms for people with chronic lung disease	Strong odour

conditions are expected for at least six hours, owners of sources of air pollution may be ordered to make preparations for curtailment of such operations. The First Air Pollution Alert Level is reached if the index reaches 50. A second alert is issued at an API of 75 and further curtailment may be ordered. The Air Pollution Episode Level occurs at an API of 100, and owners of all sources not essential to public safety may be ordered to cease operations.

In 2001, the advisory level was not reached at any of the API sites across the province. This was also true for 1998 to 2000. The last time the API reached the advisory level was in 1997; a reading of 34 was recorded at the Windsor West site. The last time the First Alert Level was reached in the province was in 1984 when an API level of 50 was recorded at the Toronto Downtown site.

Smog alert program

Smog advisories, initially called air quality advisories, were initiated in the late spring of 1993 as a joint effort between the Ontario Ministry of the Environment and Environment Canada. They are issued to the public when widespread, elevated and persistent ground-level ozone concentrations (AQI in poor category) are forecast to occur within the next 24 hours. The smog advisory program covers southern, eastern and central Ontario where ozone levels typically exceed the one-hour AAQC of 80 ppb.

Air quality initiative and enhanced smog alert program

On May 1, 2000, Ontario's enhanced Smog Alert and Air

Table 5.2: Air Quality Index Summary (2001)

		Percentage of Valid Hours in AQI Range					Percentage of Valid Hours Pollutant Responsible for AQI > 31							No. of days AQI at least	No. of days AQI at least
Stn. ID	City/Town	Very Good 0-15	Good 16-31	Moderate 32-49	Poor 50-99	Very Poor 100+	Valid hours	SO_2	NO_2	SP	TRS	CO	O_3	1 hour > 31	1 hour > 49
12008	Windsor Downtown	63.6	29.1	6.6	0.7	0	8714	0	0	0	X	0	7.3	91	15
12016	Windsor West	64.4	28.1	6.7	0.8	0	8507	0	0	0	1	X	6.5	101	19
13021	Merlin	44.2	46.2	8.4	1.2	0	8484	X	X	X	X	X	9.6	103	22
14064	Sarnia	47.4	44.3	7.2	1.1	0	8714	0	0	0	0.1	0	8.2	105	19
15020	Grand Bend	32.5	56.1	9.8	1.6	0	8646	X	X	X	X	X	11.4	128	23
15025	London	53.9	38.4	6.9	0.8	0	8679	0	0	0.1	X	0	7.6	88	14
18007	Tiverton	20.8	67.3	10.7	1.2	0	8682	X	X	X	X	X	11.9	118	16
22071	Simcoe	36.3	52.1	10.3	1.3	0	8604	0	0	X	X	0	11.6	117	25
22901	Long Point	35.2	49.8	12.4	2.6	0	8443	0	0	X	X	0	15.0	125	34
26060	Kitchener	48.6	43.1	7.6	0.7	0	8718	0	0	0	X	0	8.3	93	16
27067	Niagara Region	61.2	32.3	6.1	0.4	0	8678	0	0	0	X	0	6.5	74	12
28028	Guelph	41.3	48.6	8.9	1.2	0	8707	X	X	0	X	X	10.1	108	19
29000	Hamilton Downtown	65.1	29.3	5.1	0.5	0	8723	0	0	0	0.2	0	5.4	70	10
29114	Hamilton Mountain	52.9	38.5	7.7	0.9	0	8725	0	0	0	0.2	0	8.4	94	19
29118	Hamilton West	66.2	29.2	4.2	0.4	0	8689	0	0	0	0	0	4.6	52	7
31103	Toronto Downtown	59.7	34.8	5.0	0.5	0	8660	0	0	X	X	0	5.5	77	13
33003	Toronto East	60.2	33.6	5.5	0.7	0	8699	X	0	X	X	0	6.2	83	16
34020	Toronto North	54.3	39.8	5.3	0.6	0	8656	X	0	X	X	0	5.9	78	13
35003	Toronto West	61.6	32.1	5.7	0.6	0	8637	0	0	X	X	0	6.3	88	13
44008	Burlington	51.2	41.8	6.5	0.5	0	8672	0	0	X	X	0	7.0	95	13
44015	Oakville	54.9	38.5	6.1	0.5	0	8159	0	0	0	0	0	6.6	92	7
45025	Oshawa	53.1	42.3	4.2	0.4	0	8692	X	0	X	X	0	4.5	66	11
46089	Brampton	49.6	42.8	7.0	0.6	0	8717	0	0	X	X	0	7.6	95	14
46110	Mississauga	57.0	36.0	6.0	1.0	0	8735	0	0	0.1	X	0	6.9	98	19
48002	York Region	34.5	55.9	8.9	0.7	0	8687	X	0	X	X	0	9.6	112	16
49010	Dorset	32.1	58.3	8.9	0.7	0	8671	0	X	X	X	0	9.6	105	11
51001	Ottawa	55.1	39.1	5.5	0.3	0	8575	0	0	X	X	0	5.8	69	7
52020	Kingston	57.2	37.1	5.2	0.5	0	7941	X	X	X	X	X	5.7	68	10
56051	Cornwall	41.5	47.8	9.7	1.0	0	8424	0	0	X	X	X	10.7	110	19
59006	Peterborough	34.9	55.1	8.9	1.1	0	8656	0	0	X	X	0	10.0	111	18
63200	Thunder Bay	44.7	52.8	2.5	0.0	0	8735	0	0	0	0.1	0	2.4	50	0
71068	Sault Ste. Marie	47.2	48.3	4.5	0.0	0	8720	0	0	0	0.1	0	4.4	78	1
75010	North Bay	44.1	48.5	6.8	0.6	0	8635	X	0	0	X	X	7.4	83	9
77203	Sudbury	36.8	55.6	7.3	0.3	0	8734	0	0	0	0	0	7.6	97	7

Note: X - Pollutant not measured.
Parry Sound became an AQI station in summer 2001 but could not be represented in this table due to insufficient data available.

Quality Index (AQI) program was implemented. This enhanced program provides Ontarians with improved reporting through comprehensive and timely air quality readings and forecasts.

The new Air Quality Ontario initiative includes:

- A two-level air quality forecast that provides a three-day outlook, a smog watch, in addition to the current 24-hour smog advisory;
- A Smog Watch is called when there is a 50 per cent chance that a smog day is coming within the next three days;
- A Smog Advisory is called when there is a strong likelihood that a smog day is

Figure 5.2
Air Quality Index Summary
(2001)

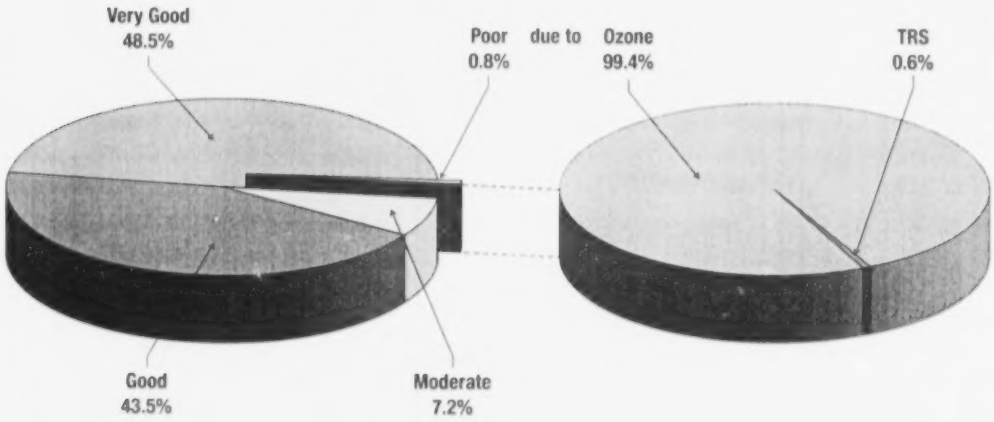
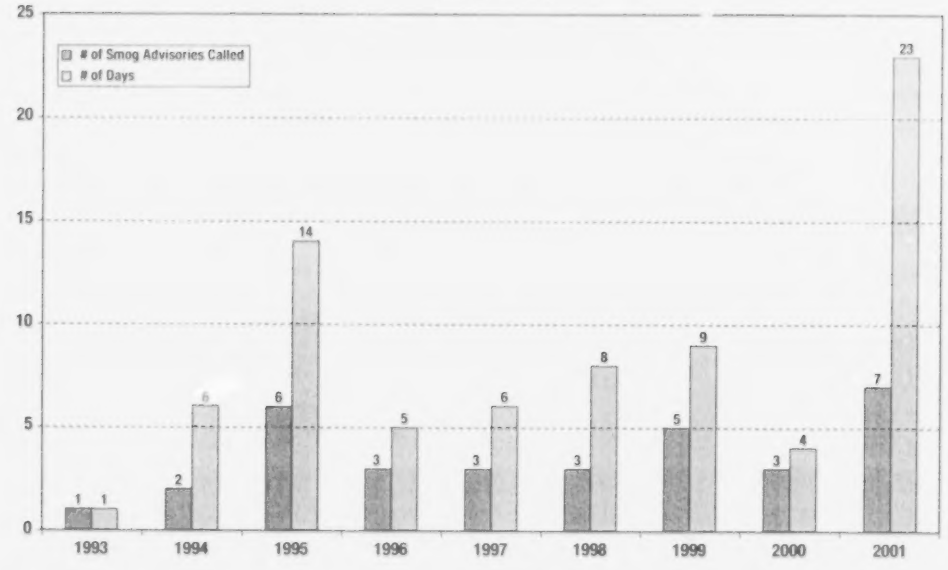


Figure 5.3
Summary of Smog Advisories Called
(1993 - 2001)

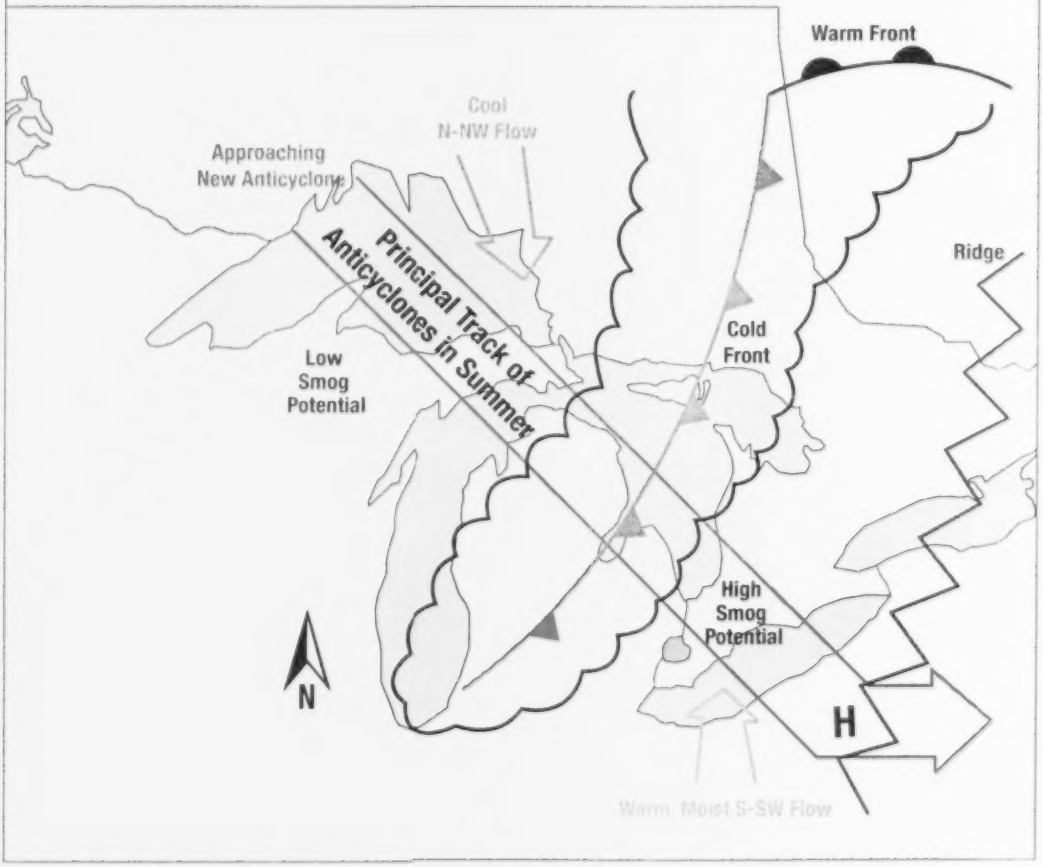


coming within the next 24 hours;

- If widespread, elevated smog levels occur without warning and weather conditions conducive to the persistence of such levels are forecast to continue for at least six hours, then a smog advisory is issued immediately;
- The public Web site, www.airqualityontario.com, where current AQI readings, smog forecasts and other air quality information are available;
- Direct e-mails of smog alerts to anyone who subscribes to the ministry's smog alert network at the above Web site;
- Increasing the number of air quality index updates from three up to six times a day, Monday to Friday, and four times a day on weekends;
- Increasing the number of AQI sites to include rural Ontario impacted by transboundary smog; and
- Providing toll-free numbers by which anyone at anytime can get updated information on the air quality (1-800-387-7768 in English and 1-800-221-8852 in French).

For the 2001 smog season, Ontarians experienced the greatest number of smog advisory days since the inception of the program in 1993 (Figure 5.3). The high number of smog advisory days was mainly attributed to a large number of hot days recorded in the province during 2001 and also to meteorological conditions favourable for the production of ozone and subsequent transboundary flow of polluted air into Ontario. In addition, improved science and the addition of an enhanced smog alert program also affected the number of advisories issued. In contrast, the summer of 2000, which was wet with only two hot

Figure 5.4
Generalized Synoptic Weather Pattern Over Southern Ontario Conducive to Elevated Pollutant Levels



days, had only three advisories called for four days.

Co-operative activities with Michigan

Since May 2000, during the smog season from May to September, air quality and meteorological discussions between Michigan and Ontario meteorologists are held twice per week or more frequently if there is potential for a smog advisory in Ontario or an ozone action day in Michigan. Although ozone action days in Michigan and smog advisories in Ontario are not triggered at the same levels, the weather conditions conducive to high levels of smog are often common to both airsheds and hence can be agreed upon for the issuance of smog warnings.

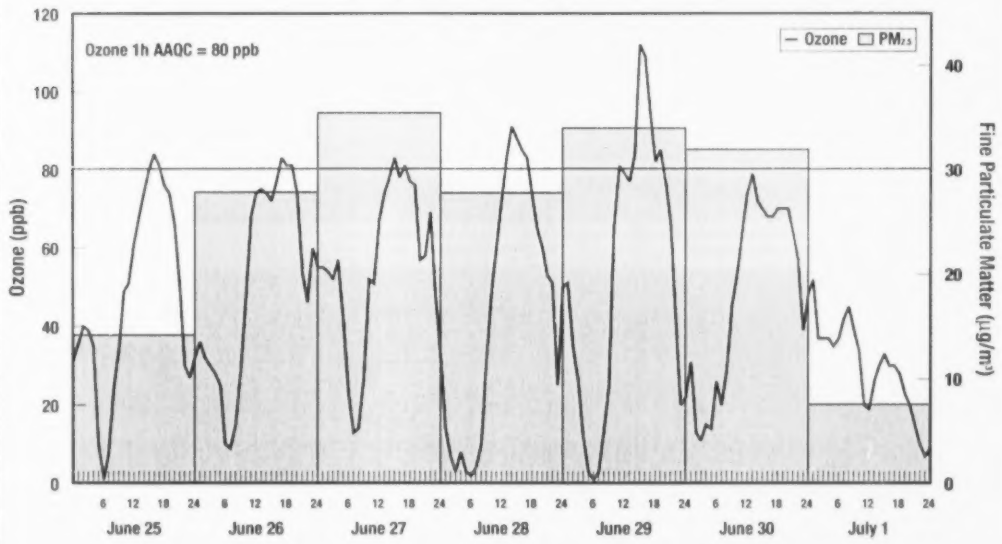
2001 smog episodes

Smog episodes in Ontario are often a part of a regional weather condition that prevails over much of northeastern North America. For southern Ontario, it is a significant transboundary problem. Elevated levels of ozone and $PM_{2.5}$ are often due to weather patterns that affect the lower Great Lakes region. Figure 5.4 illustrates a generalised summer synoptic weather pattern over southern Ontario during high smog conditions. This results in the long-range transport of smog pollutants from neighbouring U.S. industrial and urbanised states during warm south to south-westerly air flow conditions.

The summer of 2001 was characterised by hot and dry conditions and the issuance of a record-breaking number of smog advisory days across southern, central and eastern Ontario. For Ontario as a whole, there were seven smog advisories, covering 23 days. Many of these advisories were widespread and covered large geographical areas, with elevated smog levels of varying duration, from a one-day event on June 19, 2001 to five-day events on June 26 to June 30, 2001, and July 20 to July 24, 2001.

Widespread elevated levels of smog were actually recorded on the first day of the smog season, May 1, 2001. This was an unexpected one-day event which resulted in maximum one-hour ozone levels of 93 ppb at Grand Bend and 92 ppb at Simcoe in the southwest, 81 ppb in Toronto and 91 ppb at Peterborough downwind of Toronto, 96 ppb at Parry Sound and 97 ppb at Dorset and 86 ppb at North Bay. The one-hour Ontario criterion of 80 ppb was exceeded at 18 sites. Fine particulate matter

Figure 5.5
Ozone and Fine Particulate Matter in Downtown Windsor
(June 25 - July 1, 2001)



did not exceed 30 µg/m³, which is the 24-hour CWS basis, at any site in the network on this date. Typically, 24-hour $PM_{2.5}$ levels were in the 20 to 25 µg/m³ range across southern Ontario.

The first official smog advisory was issued on May 3, 2001. This two-day event was the earliest in the season that a smog advisory has been issued since the inception of the smog advisory program in 1993.

The most significant one-day event of the season occurred on June 19, 2001. A strong south-westerly flow of warm air, with winds 30-40 km/h and gusting up to 70 km/h, invaded most of southern, eastern and central Ontario as a warm sector of polluted air moved across the districts. This was eventually pushed out of the area by a rapid-moving cold front along with cloudiness and precipitation moving across southern Ontario overnight. Maximum one-hour ozone levels were typically in the 90 to 110 ppb range across southern Ontario and the one-hour ozone Ontario criterion was exceeded at 30 AQI sites. The highest level, a one-hour value of 128 ppb, occurred at Long Point on the northern shores of Lake Erie. The 24-hour $PM_{2.5}$ levels on this day ranged typically between 15 to 20 µg/m³ across the region.

The major record-breaking five-day smog event of the season occurred from June 26 to June 30, 2001. A surface high pressure over the eastern Great Lakes area remained nearly stationary during this period. Winds were light to moderate and south-westerly, allowing warm air to continue to flow northward into Ontario. On June 25, six sites, mainly in the southwestern part of the province, exceeded Ontario's AAQC for ozone. The following day, June 26, elevated ozone levels became widespread encompassing 19 sites in south-western Ontario, across the GTA, downwind of Toronto, and over central Ontario. Widespread elevated levels persisted for the next four days, June 27 to June 30 covering southern, eastern and central regions. The one-hour ozone criterion was exceeded at 30 AQI sites on June 27, 24 AQI sites on June 28, and 30 AQI sites on June 29 and June 30. The smog episode came to an abrupt end the night of June 30 as a cold front moved south-eastward across the regions and pushed the polluted air out of the province. Peak hourly readings were 103 ppb at Peterborough on June 26, 119 ppb at Sarnia on June 27, 121 ppb at Mississauga on June 28, 137 ppb at Long Point on June 29 and 98 ppb at Long Point on June 30. The 24-hour $PM_{2.5}$ levels exceeded 30 µg/m³ on four of the five days, June 27 to June 30 inclusive, with peak 24-hour levels in the 35-40 µg/m³ range on June 27 and 28. On June 26, levels were typically between 20 and 30 µg/m³ across southern Ontario. Figure 5.5 depicts the ozone and $PM_{2.5}$ levels for downtown Windsor during this episode. Ozone exceeded the one-hour criterion on five days, June 25 to June 29, 2001, inclusive. Fine particulate matter exceeded the 24-hour average of 30 µg/m³ on three days during this episode. The figure also illustrates the importance of transboundary flow, and the fact that both ozone and $PM_{2.5}$ are elevated during smog episodes.

For 2001, all the smog episodes (due to ozone and/or $PM_{2.5}$) occurred during the traditional summer smog season, May to September. There were no $PM_{2.5}$ episodes during the winter months in 2001.

Air Toxics - Selected VOCS

Characteristics, sources and effects

Certain volatile organic compounds (VOCs) warrant special concern because they play an important role in the formation of ground-level ozone and $PM_{2.5}$. Volatile organic compounds that contribute to the formation of ozone typically have a short life span in the atmosphere. In contrast, VOCs, which are least reactive to ozone formation, are capable of being transported very long distances and do not break down in the troposphere

VOCs are emitted into the atmosphere from a variety of anthropogenic sources, including vehicles, fossil fuel combustion, steel-making, petroleum refining, fuel-refilling, industrial and residential solvent use, paint application, manufacturing of synthetic materials (e.g. plastics, carpets), food processing, agricultural activities and wood processing and burning. Specialised, non-routine

monitoring and analytical techniques are required to measure VOCs because they are usually present in the atmosphere in a gaseous form at ultra-trace concentrations.

VOC monitoring

VOC samples are collected by automatically drawing ambient air into empty stainless steel canisters over a 24-hour period (midnight to midnight), following the National Air Pollution Surveillance (NAPS) sampling schedule (every sixth day) for urban sites. VOC samples at rural sites are usually collected every three days from 12:00 to 16:00 EST. Concentrations for 143 selected VOCs are reported for each sample. The list of 143 selected VOCs and their statistics appear in the separate Appendix document.

For purposes of this report, data from 1993 to 2001 for seven ambient monitoring stations (Windsor, Sarnia, Hamilton, Simcoe, Egbert, Stouffville and Ottawa) are included in this discussion. The monitoring sites described in this report are displayed in Figure 6.1. Data from these sites are provided by Environment Canada as part of the NAPS program.

Benzene, toluene and o-xylene (BTX)

Benzene is a volatile aromatic hydrocarbon, which is primarily used in the production of plastics and other chemical products. Large quantities of benzene are obtained from petroleum, either by direct extraction from certain types of crude oils or by chemical treatment of gasoline. Benzene is classified as a human carcinogen.

Toluene is an aromatic hydrocarbon that is used to make chemicals, explosives, dyes and many other compounds. It is used as a solvent for inks, paints, lacquers, resins, cleaners, glues and adhesives. Toluene is found in gasoline and aviation fuel. Studies reveal that toluene affects the central nervous

Figure 6.1
Location of Ambient VOC Monitoring Sites Across Ontario (2001)

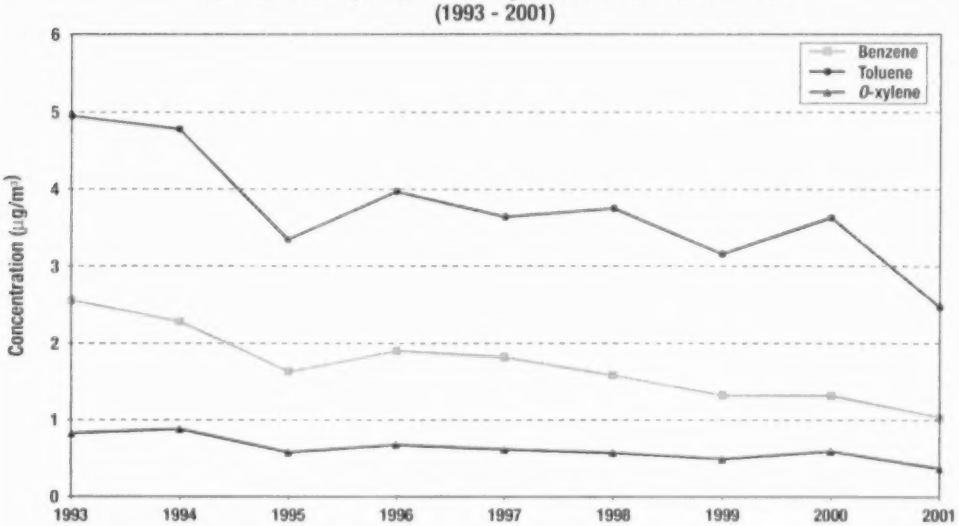
Note: Data from these sites are provided by Environment Canada as part of the NAPS program.

system of humans and animals; however, there is no evidence to classify it as a carcinogen.

Like benzene and toluene, *o*-xylene is an aromatic hydrocarbon. It is released directly into the atmosphere by manufacturers of motor vehicles and equipment, manufacturers of metal cans and shipping containers, and oil refining.

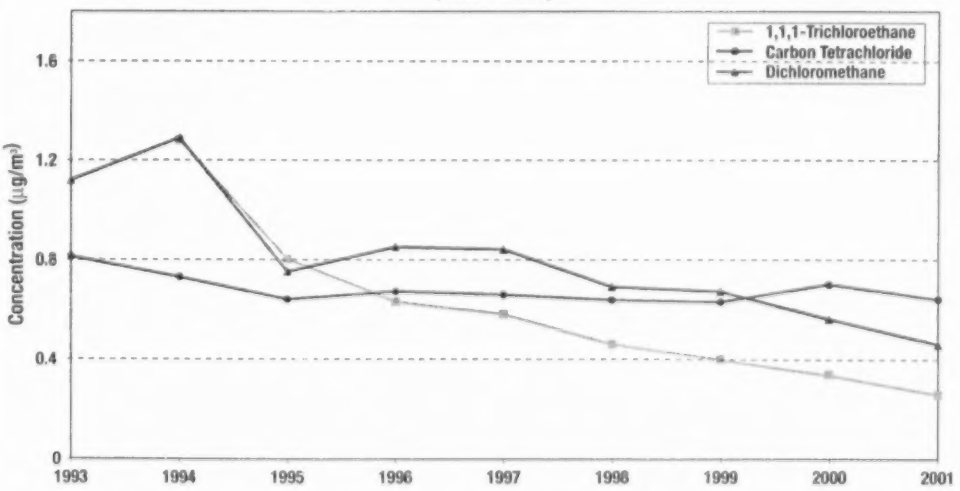
Sources of *o*-xylene, as a result of human activity, include oil refining, motor vehicles, wood-burning stoves and fireplaces, whereas natural sources include coal tar, oil, forest fires and

Figure 6.2
Trend of Benzene, Toluene and *O*-xylene Concentrations in Ontario (1993 - 2001)



Note: Annual composite mean based on seven sites over nine years; data from these sites are provided by Environment Canada as part of the NAPS program.

Figure 6.3
Trend of 1,1,1-Trichloroethane, Carbon Tetrachloride and Dichloromethane Concentrations in Ontario (1993 - 2001)



Note: Annual composite mean based on seven sites over nine years; data from these sites are provided by Environment Canada as part of the NAPS program.

plant volatiles. *O*-xylene affects the central nervous system as a depressant. It has not been classified as a carcinogen.

Motor vehicle exhaust is the largest source of BTX. These compounds are considered toxic and are very reactive in forming ground-level ozone and $PM_{2.5}$ Figure 6.2 shows trends of benzene, toluene, and *o*-xylene for the period from 1993 to 2001. All three VOCs show a decreasing trend over the nine-year period. The most significant decline was in toluene where the annual composite mean decreased by 50 per cent when comparing 1993 to 2001.

1,1,1-trichloroethane, carbon tetrachloride and dichloromethane

Hydrocarbons that add or substitute one or more atoms of chlorine, bromine, fluorine or iodine, are halogenated compounds, such as 1,1,1-trichloroethane, carbon tetrachloride and dichloromethane. 1,1,1-trichloroethane is a colourless liquid with a sweet odour that evaporates quickly into a vapour. It is found in many common products such as glue, paint, industrial degreasers and aerosol sprays. Carbon tetrachloride is also a clear liquid but it is most often found as a colourless gas. It has a strong aromatic odour that can be detected at low levels. Carbon tetrachloride is produced for use in the manufacturing of refrigerants and propellants for aerosols. Dichloromethane, another colourless liquid with a sweet odour, is most commonly used as a paint remover. It is also used as a solvent and cleaning agent, a fumigant for strawberries and grains, and to extract substances from produce.

Figure 6.3 shows decreasing trends in 1,1,1-trichloroethane from 1994 to 2001, and carbon tetrachloride and dichloromethane for the period from 1993 to 2001. All three toxics show a decreasing trend over the periods.

VOC monitoring survey in Toronto

The Ontario Ministry of the Environment conducted an air monitoring survey to measure ambient levels of selected VOCs at two locations in Toronto. The survey took place in May and August of 2001 at two locations near Highway 401. One location was in Toronto's west end at Islington and Highway 401, and the other in Toronto's east end near Kingston Road and Highway 401.

Air samples were collected on glass cartridges containing graphitized carbon adsorbents. Air was drawn through the cartridge by a portable air sampling pump. The VOC vapours were adsorbed by the cartridge and then concentrated. The cartridges were then analysed using the Trace Atmospheric Gas Analyser (TAGA) mass spectrometry method.

The cartridge analysis collected data for 49 VOCs, however, only 14 measured above the TAGA detection limit. The 14 detectable VOCs were 1,3-butadiene, isoprene, n-hexane, benzene, toluene, ethyl benzene, *o*-xylene, *m*, *p*-xylene, styrene, isopropyl benzene, 1,3,5-trimethylbenzene, 1,2,4-trimethylbenzene, n-butyl benzene and naphthalene. BTX were the most abundant of the 14 VOCs measured, however, all VOC levels were well below ministry standards. (This data is not available in the Appendix).

Georgian Bay Air Quality Study 2001

The ministry conducted an air quality study of the Georgian Bay area during the summer of 2001. Hourly concentrations of pollutants were measured at a number of sites along the shores of Georgian Bay using the state-of-the-art Mobile Air Quality Index (AQI) Unit. Six pollutants were measured in this study: ozone (O_3), fine particulate matter ($PM_{2.5}$), nitrogen dioxide (NO_2), sulphur dioxide (SO_2), carbon monoxide (CO) and mercury (Hg).

The study took place from July 1 to July 25, 2001, using the

Mobile AQI Unit, which was located at Tehkummah, Manitoulin Island from July 1 to 6, Still River from July 6 to 13, and the Bruce Peninsula National Park from July 13 to 25. In this part of the study, the measurements taken by the Mobile AQI Unit were compared to those recorded at the Parry Sound AQI site. The measurements from the Parry Sound AQI site were also compared to measurements taken at sites in the Toronto area.

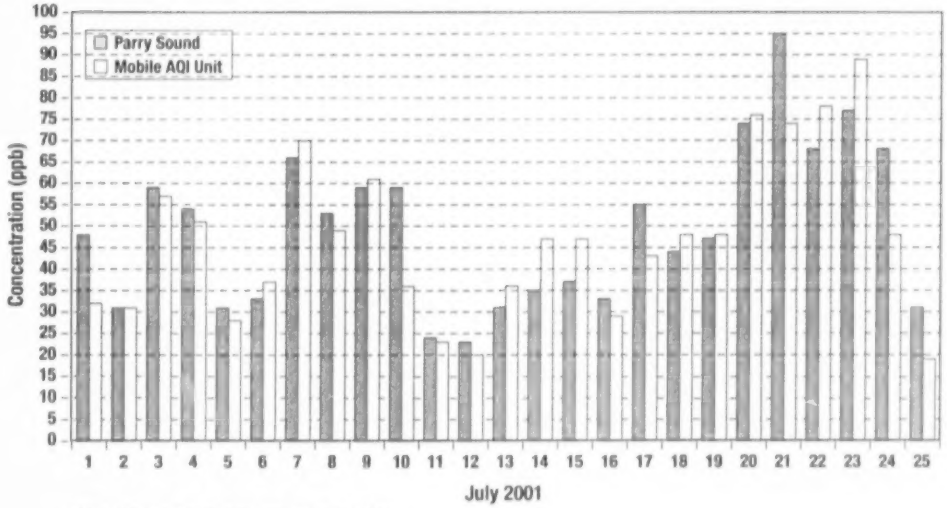
RESULTS

Study period: July 1 to July 25, 2001

The daily ozone one-hour maximum concentrations measured by the Mobile AQI Unit were compared with the maximum ozone concentrations measured at the Parry Sound AQI site for the period from July 1 to July 25, 2001 (Figure 7.1). The highest daily ozone one-hour maximum concentration recorded at the Parry Sound AQI site was 95 ppb on July 21, 2001. The corresponding highest value for the Mobile AQI Unit was 89 ppb on July 23, 2001, when it was located at the Bruce Peninsula National Park. Both values exceeded the one-hour provincial AAQC of 80 ppb for ozone. Figure 7.2 shows the air flow into the Georgian Bay area on July 21 and July 23. The flow was primarily from the U.S. through the state of Michigan on July 21 and through the state of Ohio on July 23. This indicates that the ozone was transported into the area from the U.S. Maximum air temperatures during the three-day period ranged from 28°C to 30°C. Overall, there were no significant differences between the concentrations measured by the Mobile AQI Unit and at the Parry Sound AQI site. There was a very high correlation coefficient of 0.86 between the ozone concentrations measured at the locations studied here, indicating that the ozone concentrations measured at the Parry Sound AQI site are representative of concentrations across the Georgian Bay area.

Since the Parry Sound AQI site does not monitor fine particulate matter, daily $PM_{2.5}$ concentrations measured by the Mobile AQI Unit in the Georgian Bay area were compared with concentrations recorded at Dorset and Tiverton from July 1 to July 25, 2001. The Dorset AQI site is located east of Georgian Bay, while the Tiverton AQI site is located

Figure 7.1
Daily Ozone One-Hour Maximum Concentrations in the Georgian Bay Area (July 1-25, 2001)



Note: Manitoulin Island from July 1-6, 2001;
Still River from July 7-13, 2001;
Bruce Peninsula National Park from July 13-25, 2001.

southwest of the area. The highest 24-hour average $PM_{2.5}$ concentration was recorded on July 21, 2001. The measurements were 31.1 µg/m³, 30.8 µg/m³, and 28.2 µg/m³ for Tiverton, Dorset, and the Mobile AQI Unit, respectively. This was the only day that ambient 24-hour concentrations were greater than the 30 µg/m³ CWS basis at the Dorset and Tiverton AQI sites during the study period. Although the correlation coefficients between the sites were very high, indicating a strong relationship between the measured concentrations, the concentrations measured at Dorset and the Mobile AQI Unit were similar in contrast to the higher levels at Tiverton. This suggests that the measurements at Dorset are more representative of concentrations recorded in the Georgian Bay area.

The maximum hourly average concentrations of O_3, $PM_{2.5}$, NO_2, SO_2, CO and Hg recorded at Toronto and by the Mobile AQI Unit during the period July 1 to July 25, 2001, are shown in Table 7.1. In the Toronto area, all measurements were recorded at the Toronto Downtown site except for the Hg measurement, which was recorded at the Toronto West site. The maximum ozone concentration during this period recorded by the Mobile AQI Unit was 10 ppb higher than the maximum at Toronto Downtown. Generally, ozone is lower in urban areas because it is removed by reaction with nitric oxides emitted locally by vehicles. Fine particulate measurements were comparable. The maximums for NO_2, CO and Hg were significantly higher in the Toronto area than in the Georgian Bay area, reflecting the impact of urban sources of these pollutants. The relative high SO_2 concentration recorded by the Mobile AQI Unit was measured on July 15, 2001, a day when the air flow was northerly.

Conclusion

The high correlation coefficients

Figure 7.2
Wind Trajectories into the Georgian Bay Area for July 21 and July 23, 2001

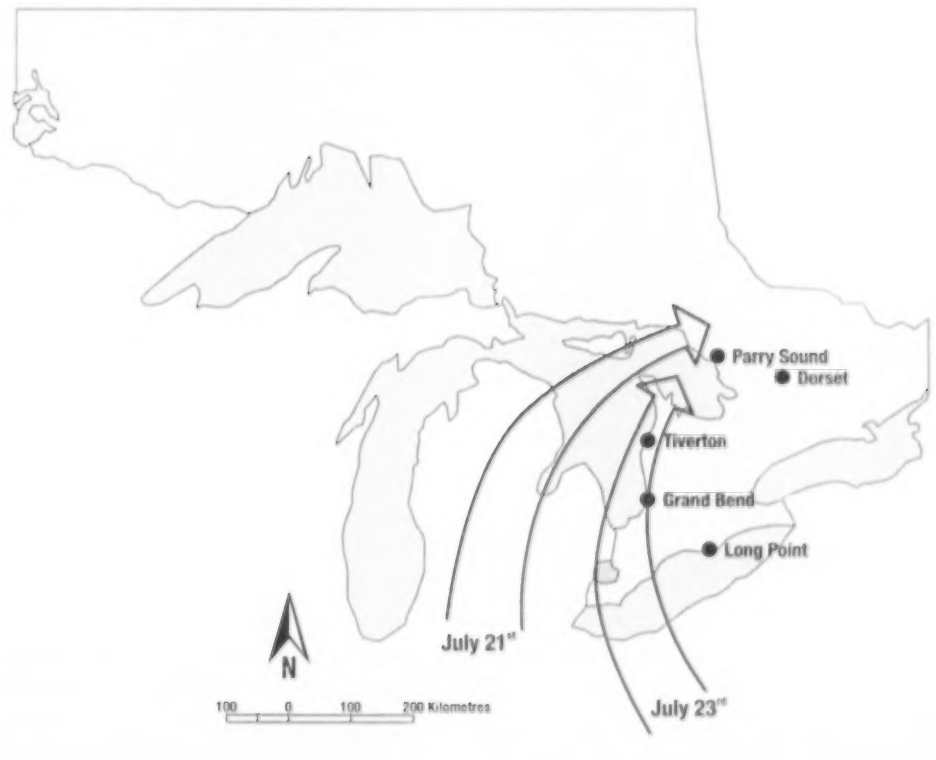


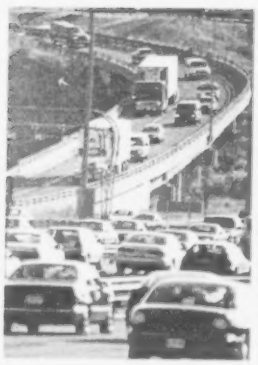
Table 7.1: Comparison of Maximum Hourly Concentrations of Pollutants						
Station	**O_3 (ppb)**	**$PM_{2.5}$* (µg/m³)**	**NO_2 (ppb)**	**SO_2 (ppb)**	**CO (ppm)**	**Hg (ng/m³)**
Mobile AQI Unit	89.0	32.0	4.4	30.0	0.74	1.9
Toronto	79.0	30.0	71.0	19.0	2.20	5.9

** The averaging period for $PM_{2.5}$ is 24 h.*

between ozone data collected by the Mobile AQI Unit and the Parry Sound site during the period from July 1 to July 25, 2001, suggest that the Parry Sound monitoring site is representative of measurements across the Georgian Bay area. The results also indicate that $PM_{2.5}$ measurements at Dorset are representative of $PM_{2.5}$ levels that residents in the Georgian Bay area experience. The maximums for NO_2, CO and Hg were significantly higher in the Toronto area than in the Georgian Bay area, reflecting the impact of local sources of these pollutants. There are occasions when ozone levels can be higher in the Georgian Bay area than the traditional areas to the south, for example, when the polluted air enters the region directly from upper Michigan and crosses Lake Huron. As it has been stated in the ozone chapter of this report, rural sites along the eastern shore of Lake Huron and northern shore of Lake Erie record on average, the highest ozone concentrations mainly due to the long-range transport of air pollution into the area.

For a more detailed analysis of the Georgian Bay Air Quality Study 2001, visit the ministry Web site (www.ene.gov.on.ca) for the complete publication.

Summary



Thirty-one years after the first edition of this report in 1971, there has been consistent improvement in the state of air quality in Ontario (as measured by a number of parameters) despite significant increases in population, economic activity and vehicle-kilometres travelled. Significant decreases have been achieved for the following common pollutants: sulphur dioxide, carbon monoxide, nitrogen dioxide and total reduced sulphur compounds.

Encouraging as this is, there remains a great deal of work to be done. The Ontario government is directing increased emphasis on two key components of smog, namely ozone and $PM_{2.5}$, which recent scientific evidence suggest have significant health effects.

Data analysis strongly indicates that neighbouring U.S. states – namely Ohio, Illinois and Michigan – are significant contributors to elevated levels of ozone and $PM_{2.5}$ in southern Ontario. The contributions from long-range transport and transboundary movement of these pollutants need further assessment. Continued monitoring is required to evaluate trends and determine the effectiveness of reduction and abatement strategies.

Ontario has continued to review and expand its existing air monitoring network by deploying real-time monitors, namely the Tapered Element Oscillating Microbalance (TEOM), for the measurement of $PM_{2.5}$. In 1996, there was only one $PM_{2.5}$ monitor operating, however in 2001, there is a total of 23 TEOMs measuring fine particulate matter across the province. The collection and assessment of such data will allow for improvement to the reporting of important air quality information to all Ontarians.

The Ontario government has committed itself to a series of initiatives to help improve air quality. These initiatives include the following:

- The expansion of the Drive Clean program, which started in April 1999, now extends across Ontario's smog corridor (Windsor to Ottawa). Drive Clean is an emission-testing program to reduce smog-related emissions from light-duty vehicles, heavy-duty trucks and buses. The Drive Clean program is also expected to reduce 100,000 tonnes of greenhouse gas emissions annually – the equivalent of taking 23,000 cars off the road permanently.

- Ontario's Smog Patrol provides an on-road enforcement component for Drive Clean by enforcing emissions standards under the Environmental Protection Act. The Smog Patrol is dedicated to inspecting trucks, buses and light-duty vehicles suspected of emitting excessive exhaust smoke or of having emissions control equipment that has been tampered with or removed.

- On May 1, 2000, an enhanced smog alert and AQI program was unveiled. This enhanced program provides Ontarians with improved reporting through comprehensive and timely air quality readings and forecasts. More recently, the ministry incorporated $PM_{2.5}$ into Ontario's AQI on August 23, 2002, allowing Ontarians to make better decisions to protect their health and to improve the air we all share.

- Ontario's Environmental SWAT Team, which began operation in September 2000, is a highly mobile unit dedicated to ensuring compliance with Ontario's environmental laws through tough, effective and fair enforcement.

- Ontario introduced *OnAIR*, a new on-line emissions reporting registry, which gives the public broad access to information on air pollution posted by emitters across the province. *OnAIR* is accessible through the Ministry of the Environment Web site at www.ene.gov.on.ca.

- In September 2001, the ministry strengthened 18 air standards as part of its commitment to update or develop approximately 145 human health and environmental air standards.

- The Ontario government finalised a regulation that caps emissions from the coal-fired Lakeview power station and requires it to stop burning coal by April 2005.

- Ontario ordered Inco Ltd. and Falconbridge Ltd. to reduce the allowable limits of annual SO_2 emissions by 34 per cent by December 31, 2006. This reduction will be a significant first step towards achieving Ontario's commitment to the Canada-Wide Acid Rain Strategy.

- Ontario has introduced stringent emission caps for power stations burning fossil fuel. When fully implemented in 2007, smog and acid-rain-causing emissions limits will be cut: NO_x by 53 per cent and SO_2 by 25 per cent.

Even with these initiatives, continued efforts by citizens, organisations, industries and governments are needed to help improve the quality of Ontario's air.

Glossary

Acidic deposition - refers to deposition of a variety of acidic pollutants (acids or acid-forming substances such as sulphates and nitrates) on biota or land or in waters of the Earth's surface.

Air Quality Index - real-time information system that provides the public with an indication of air quality in cities and towns across Ontario.

AQI station - continuous monitoring station used to inform the public of air quality levels on a real-time basis; station reports on criteria pollutants.

Air Pollution Index - basis of Ontario's alert and control system to warn of deteriorating air quality; derived from 24-hour running averages of sulphur dioxide and suspended particles.

Airshed - a geographical region of influence or spatial extent of the air pollution burden.

Ambient air - outdoor or open air.

Aromatic hydrocarbon - a compound where the double-bond carbon atoms occur in a ring-type pattern

Carcinogen - an agent that incites carcinoma (cancer) or other malignancy.

Continuous pollutant - contaminant for which a continuous record exists; effectively, pollutants that have hourly data (maximum 8,760 values per year except leap year – i.e. 2000 where maximum values for the year are 8,784).

Continuous station - where pollutants are measured on a real-time basis and data determined hourly (for example ozone, sulphur dioxide).

Criterion - maximum concentration or level (based on potential effects) of contaminant that is desirable or considered acceptable in ambient air.

Daily pollutant - contaminant with a 24-hour or daily value (maximum 365 values per year).

Detection limit - minimum concentration of a contaminant that can be determined.

Exceedance - violation of the pollutant levels permitted by environmental protection criteria.

Fine Particulate Matter - particles smaller than about 2.5 microns in diameter, which arise mainly from condensation of hot vapours and chemically driven gas to particle conversion processes; also referred to as $PM_{2.5}$. These are fine enough to penetrate deep into the lungs and have the greatest effects on health.

Fossil fuels - natural gas, petroleum, coal and any form of solid, liquid or gaseous fuel derived from such materials for the purpose of generating heat.

Geometric mean - statistic of a data set calculated by taking the nth root of the product of all (n) values in a data set. Provides a better indication than arithmetic mean of the central tendency for a small data set with extreme values.

Global warming - long-term rise in the average temperature of the Earth; principally due to an increase in the buildup of carbon dioxide and other gases.

Ground-level ozone - colourless gas formed from chemical reactions between nitrogen oxides and hydrocarbons in the presence of sunlight near the Earth's surface.

Inhalable particles - represent up to 60 per cent of the total suspended particulate matter; composed of both coarse (diameter 2.6 to 10.0 microns) and fine (diameter < 2.5 microns) particles; also referred to as PM_{10}.

Micron - a millionth of a metre.

Median - middle value of a set of numbers arranged in order of magnitude.

Non-continuous station - station that measures pollutant concentration on a daily, six-day frequency or monthly cycle (as for total suspended particulate matter).

Ozone episode day - a day on which widespread (hundreds of kilometres) elevated ozone levels (greater than 80 ppb maximum hourly concentration) occur simultaneously.

Particulate matter - refers to all airborne finely divided solid or liquid material with an aerodynamic diameter smaller than 100 microns.

Percentile value - percentage of the data set that lies below the stated value; if the 70 percentile value is 0.10 ppm, then 70 per cent of the data are equal to or below 0.10 ppm.

Photochemical oxidant - Air pollutants formed by the action of sunlight on oxides of nitrogen and VOCs.

Photochemical reaction - chemical reaction influenced or initiated by light, particularly ultraviolet light.

Photochemical smog - see smog.

Primary pollutant - contaminant emitted directly to the atmosphere.

Secondary pollutant - contaminant formed from other pollutants in the atmosphere.

Smog - a contraction of smoke and fog; colloquial term used for photochemical fog, which includes ozone and other contaminants; tends to be a brownish haze.

Smog advisory - public is advised when elevated pollution levels are forecast due to ground-level ozone.

Stratosphere	- atmosphere 10 to 40 kilometres above the Earth's surface.
Stratospheric ozone	- ozone formed in the stratosphere from the conversion of oxygen molecules by solar radiation; ozone found there absorbs much ultraviolet radiation and prevents it from reaching the Earth.
Suspended particles	- suspended particulate matter most likely to reach the lungs (diameter less than 25 microns).
Toxic deposition	- absorption or adsorption of a toxic pollutant at ground, vegetative or surface levels.
Toxic pollutant	- substance that can cause cancer, genetic mutations, organ damage, changes to the nervous system, or even physiological harm as a result of prolonged exposure, even to relatively small amounts.
Troposphere	- atmospheric layer extending about 10 kilometres above the earth's surface.

Abbreviations

AAQC	-	Ambient Air Quality Criteria (Ontario)
API	-	Air Pollution Index
AQI	-	Air Quality Index
AQUIS	-	Air Quality Information System
ATAD	-	Automatic Telephone Answering Device
BTX	-	benzene, toluene and o-xylene
CCME	-	Canadian Council of Ministers of the Environment
CO	-	carbon monoxide
COH	-	coefficient of haze reported as SP
CWS	-	Canada-Wide Standard
EC	-	Environment Canada
EMRB	-	Environmental Monitoring and Reporting Branch
EST	-	Eastern Standard Time
GTA	-	Greater Toronto Area
Hg	-	mercury
MOE	-	Ministry of the Environment
NAAQS	-	National Ambient Air Quality Standard (U.S.)
NO	-	nitric oxide
NO_2	-	nitrogen dioxide
NO_x	-	oxides of nitrogen
O_3	-	ozone
$PM_{2.5}$	-	fine particulate matter
SO_2	-	sulphur dioxide
SP	-	suspended particles
TAGA	-	Trace Atmospheric Gas Analyser
TEOM	-	Tapered Element Oscillating Microbalance
TRS	-	total reduced sulphur
US EPA	-	United States Environmental Protection Agency
VOCs	-	volatile organic compounds
kg	-	kilogram
ng/m³	-	nanograms (of contaminant) per cubic metre (of air)
µg/m³	-	micrograms (of contaminant) per cubic metre (of air)
ppb	-	parts (of contaminant) per billion (parts of air)
ppm	-	parts (of contaminant) per million (parts of air)

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